Smolt Survival and Travel Time & Transportation Analyses

Update with 2018 Data

NOAA FISHERIES

Northwest Fisheries Science Center

Technical Management Team

2018 Year-End Review

December 19, 2018

Steven G. Smith

steven.g.smith@noaa.gov

Outline

- Migration conditions, travel time and survival of PIT-tagged smolts through the hydropower system in 2018
  - September 19 Memo; Draft report to BPA in prep
    - Only those fish left to migrate in-river
    - Only juvenile data, not survival to adult

2018 Spring Conditions

- Flow > average throughout season (29 kcfs; 31%)
- High spill percentage, slightly > average (2006-17)
- Water warmer than average,
  esp. April and late May
- Travel times among the shortest we've seen
  - Similar to very-high flow 2017
- Transportation started earlier; 45%+ transported

2018 Spring Survival

- Chinook: average in Snake R,
  below average in lower Col R
  (38% Snake trap to Bonneville)

- Steelhead: Above average in both reaches
  (52% Snake trap to Bonneville)

- Sockeye: Above average everywhere
  (64% Lower Granite to Bonneville)

PIT-tag Data Sources

Hatchery Releases

Chief Joseph

Wells

Grand Coulee

Rocky Reach

Rock Island

Wanapum

Priest Rapids

Ice Harbor

Snake R. trap

Juvenile detectors

Lower Monumental

Little Goose

Lower Granite

Hatchery & Trap Releases

PIT tag trawl

Bonneville

The Dalles

John Day

McNary

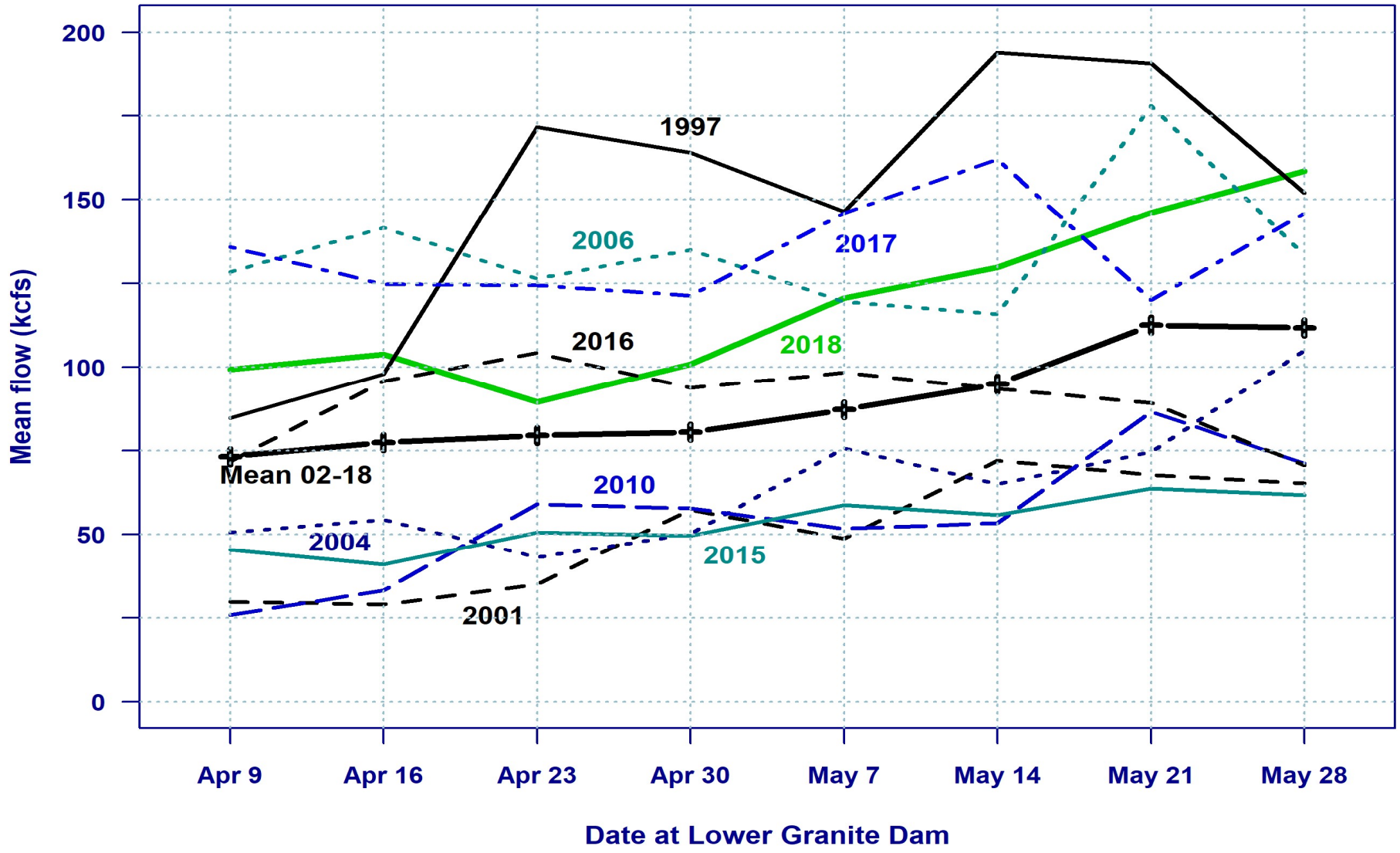
Hells Canyon

Oxbow

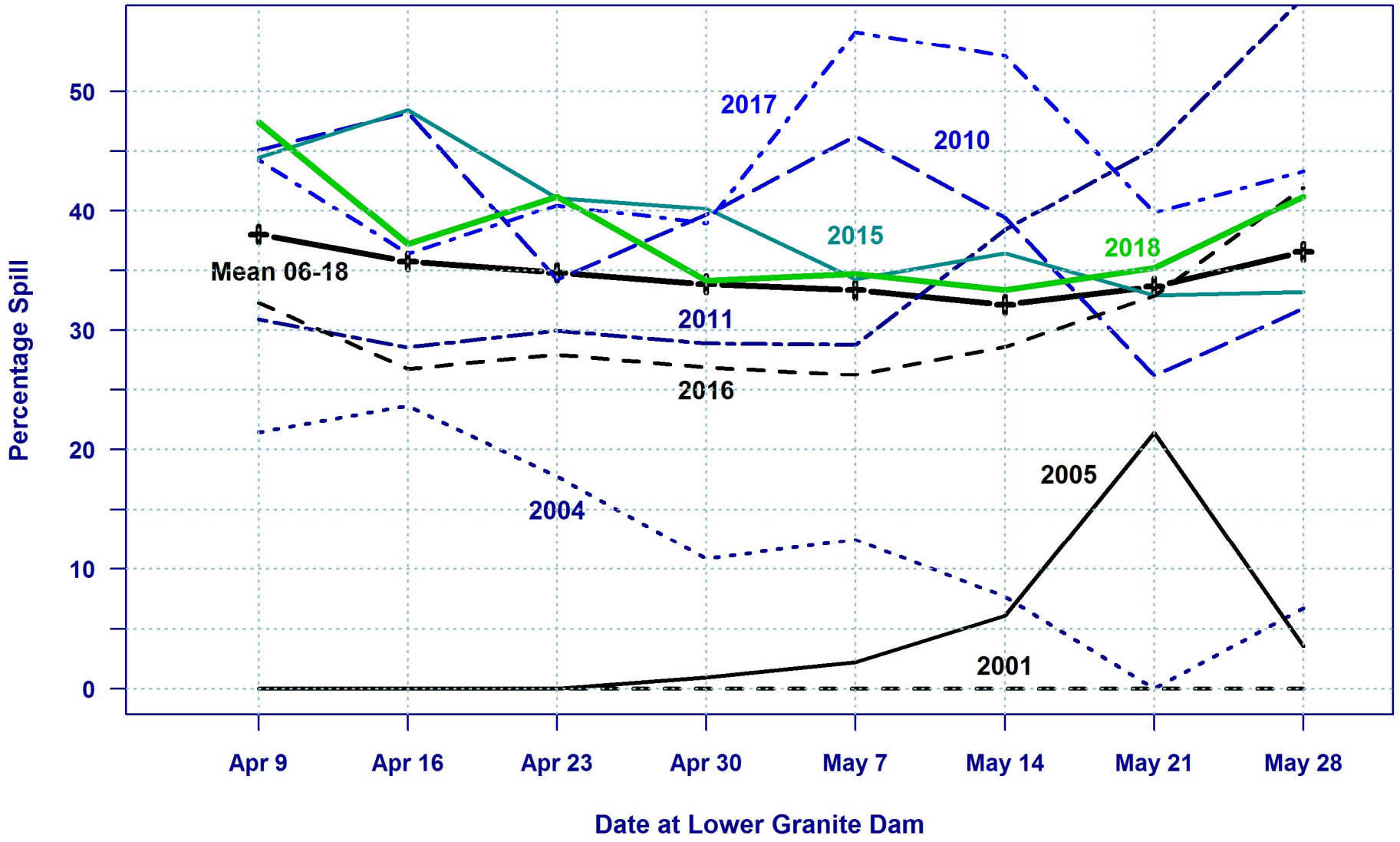
Brownlee

N

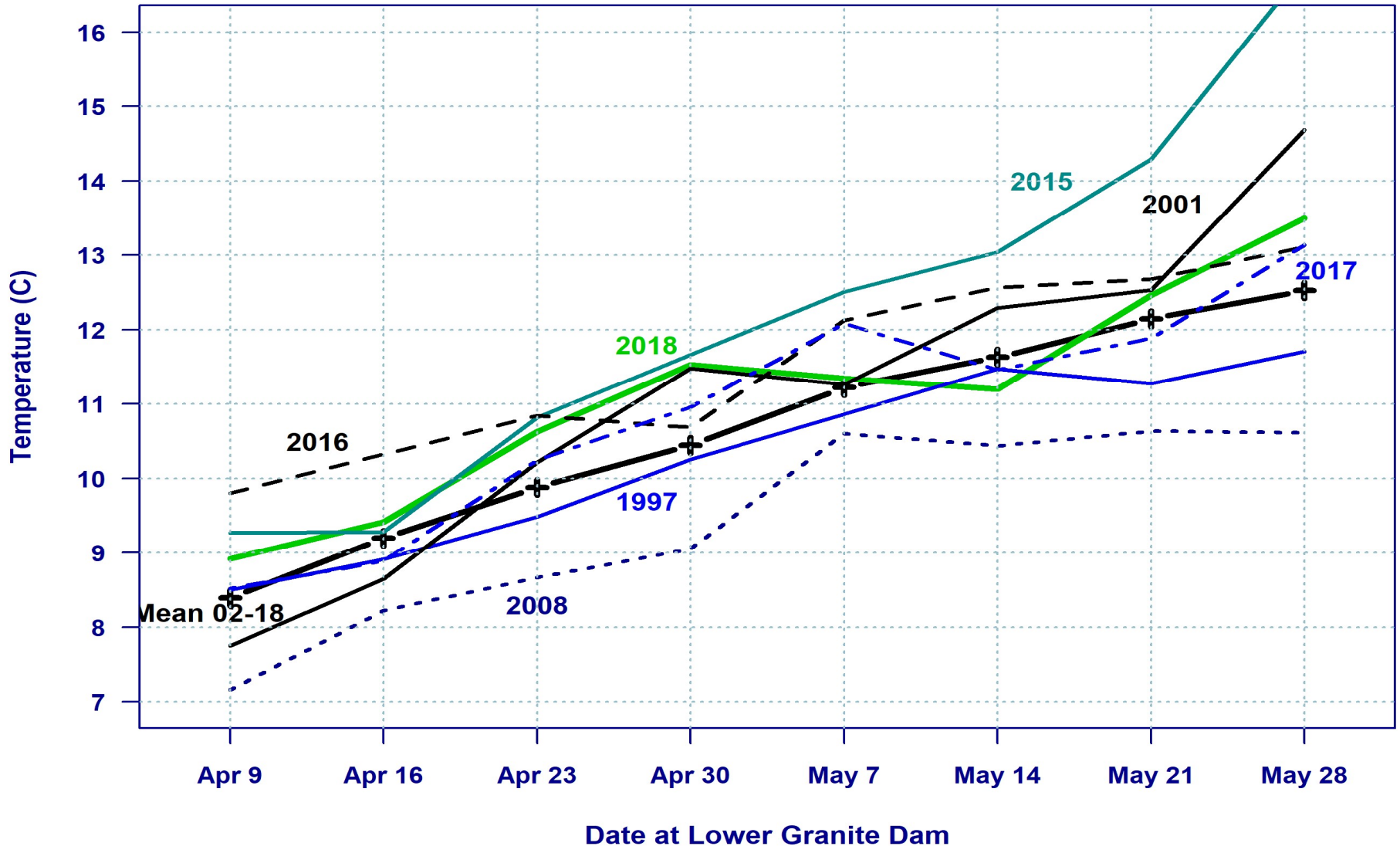
Weekly Mean Flow (kcfs)
Lower Granite Dam



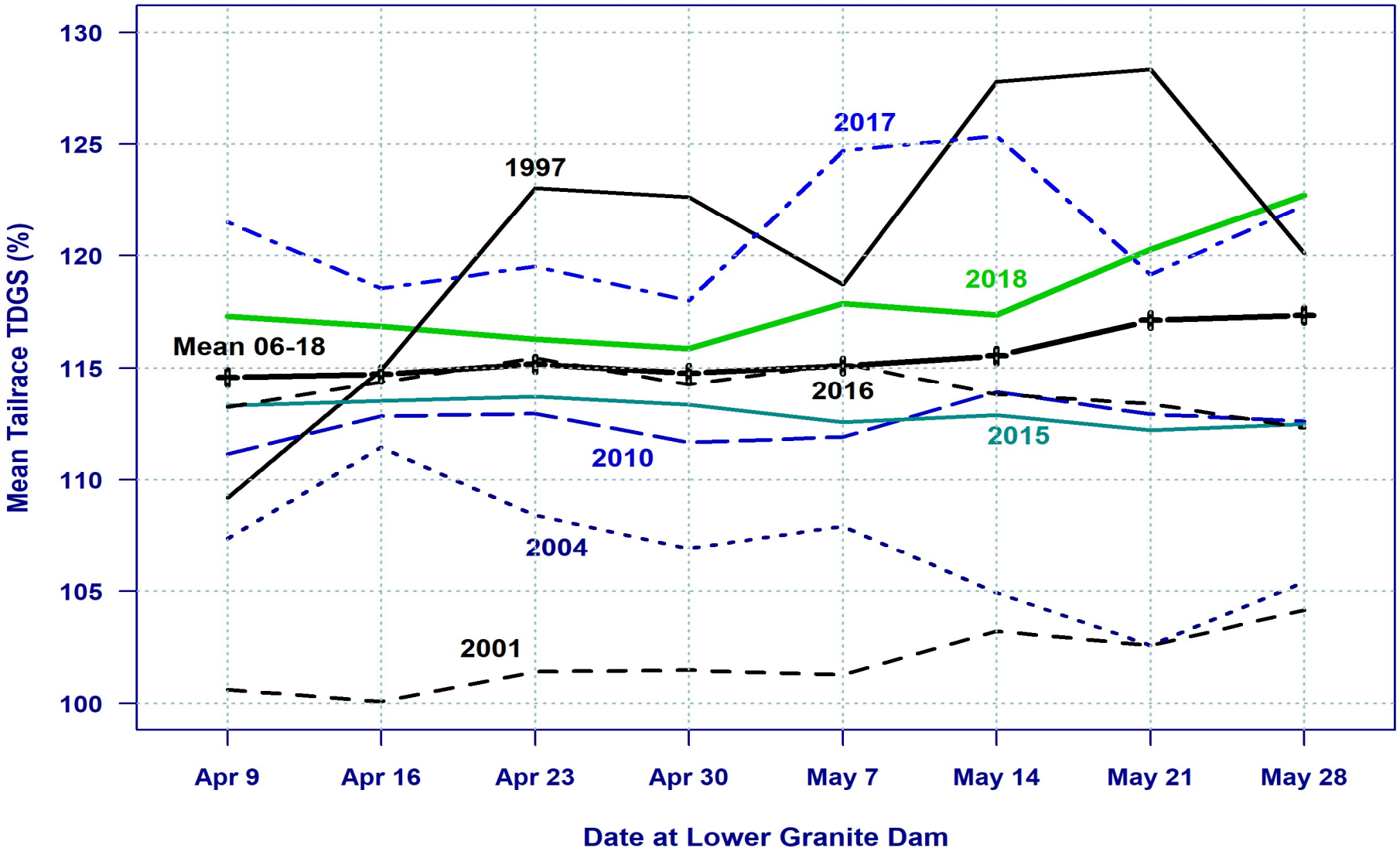
Weekly Mean %Spilled
LGR, LGS, LMN



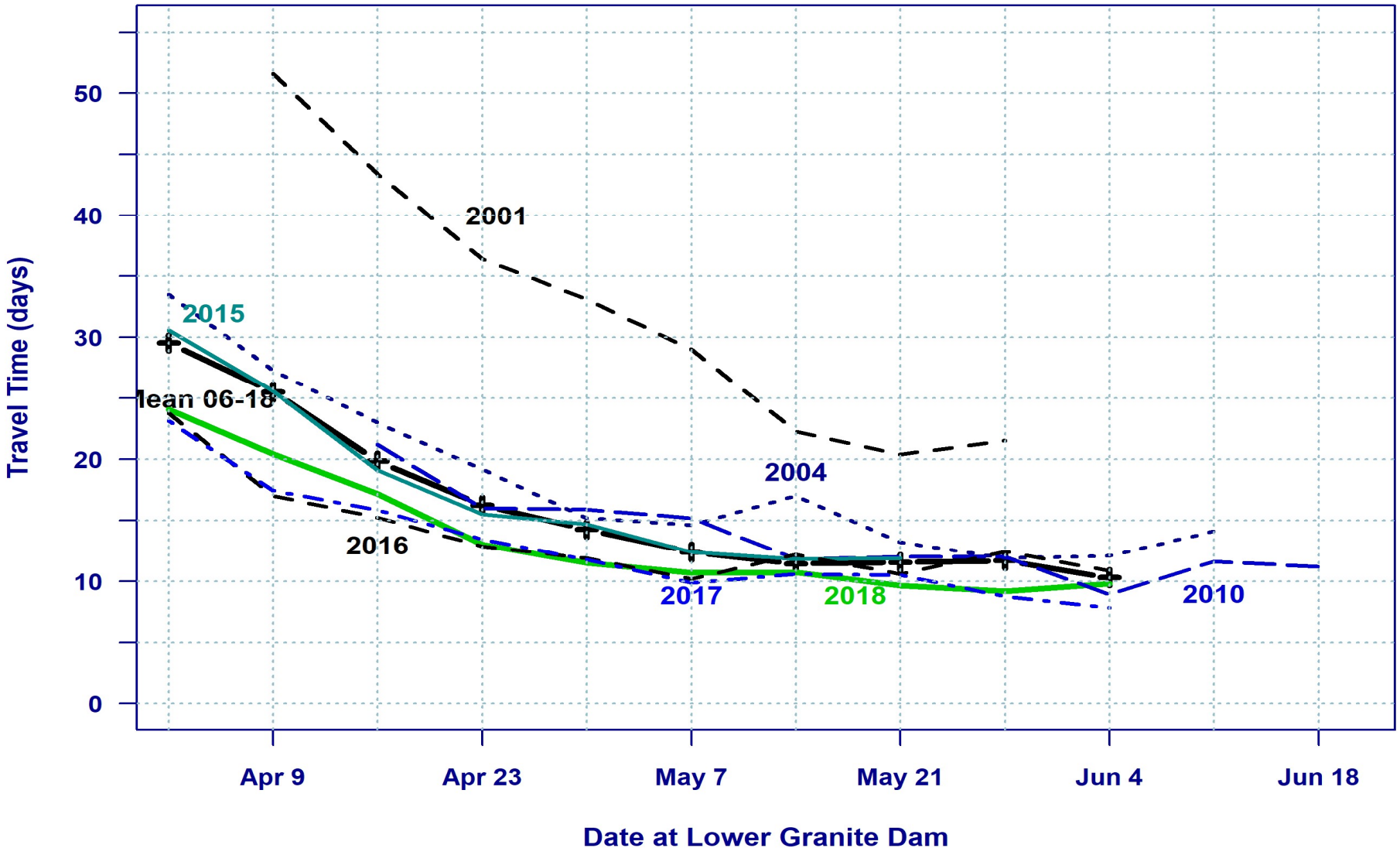
Weekly Mean Temperature
Little Goose Dam



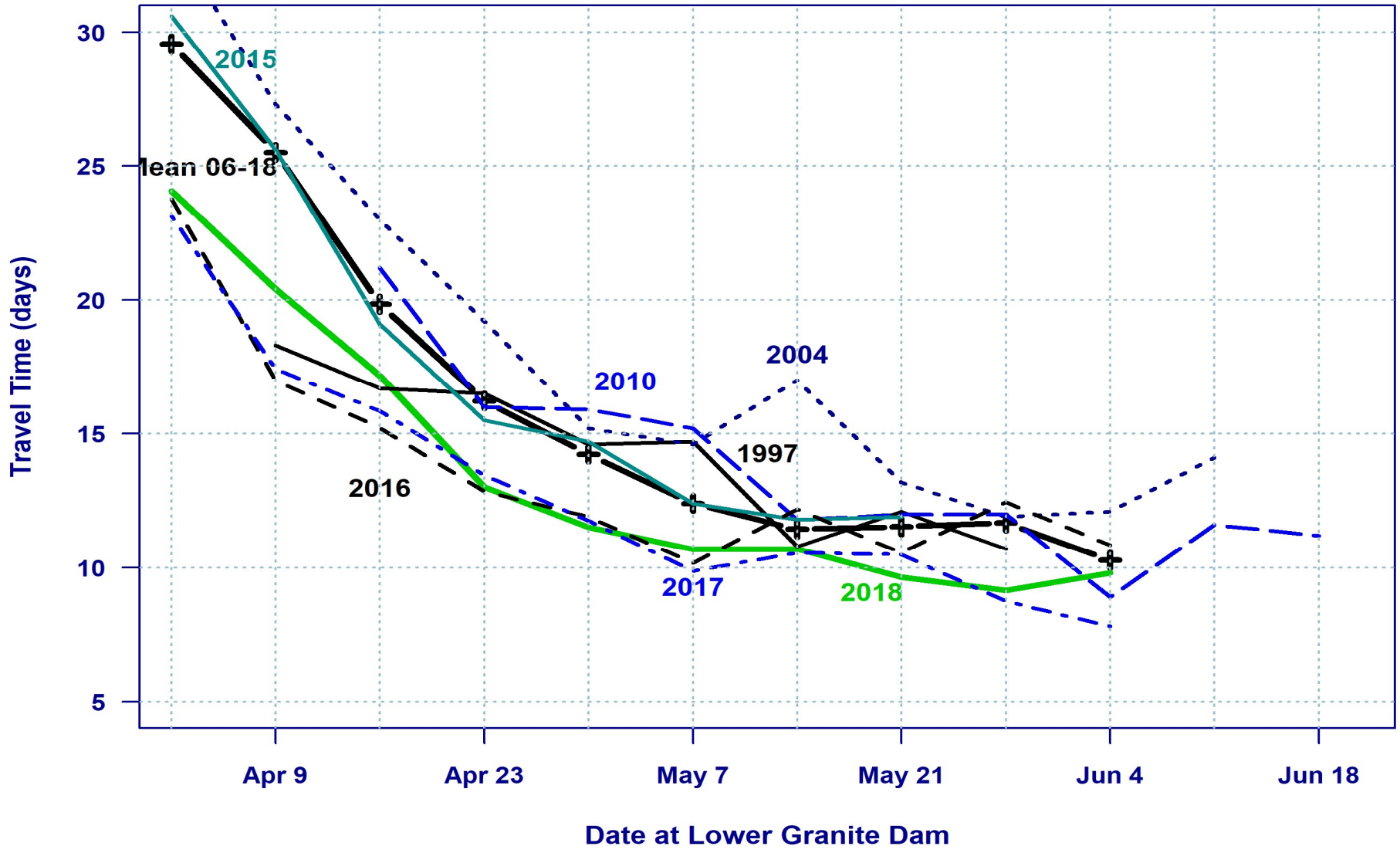
Weekly Mean Tailrace TDGS (%)
LGR, LGS, LMN



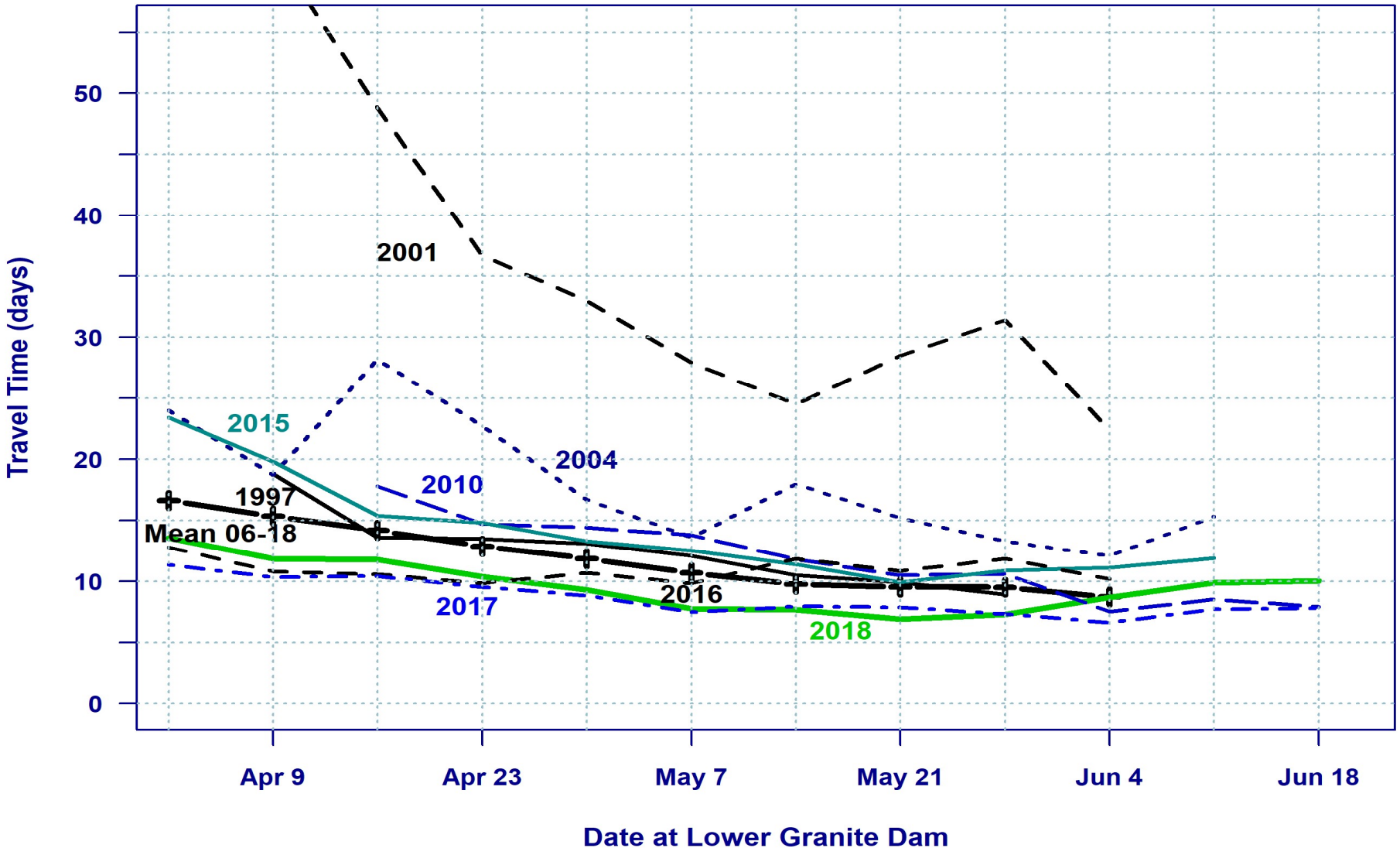
Yearling Chinook Median Travel Time
Lower Granite to Bonneville (461 km)



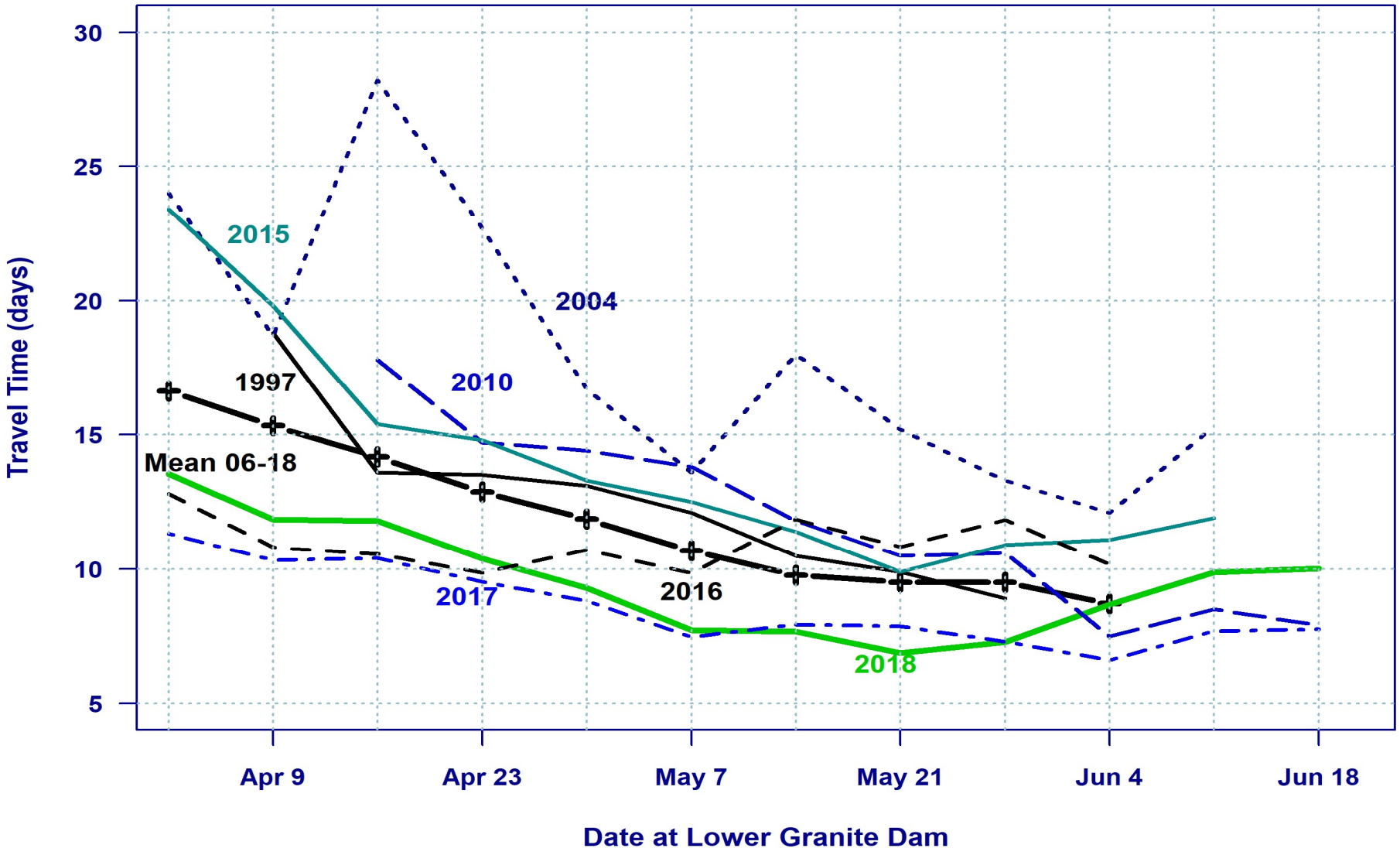
Yearling Chinook Median Travel Time
Lower Granite to Bonneville (461 km)



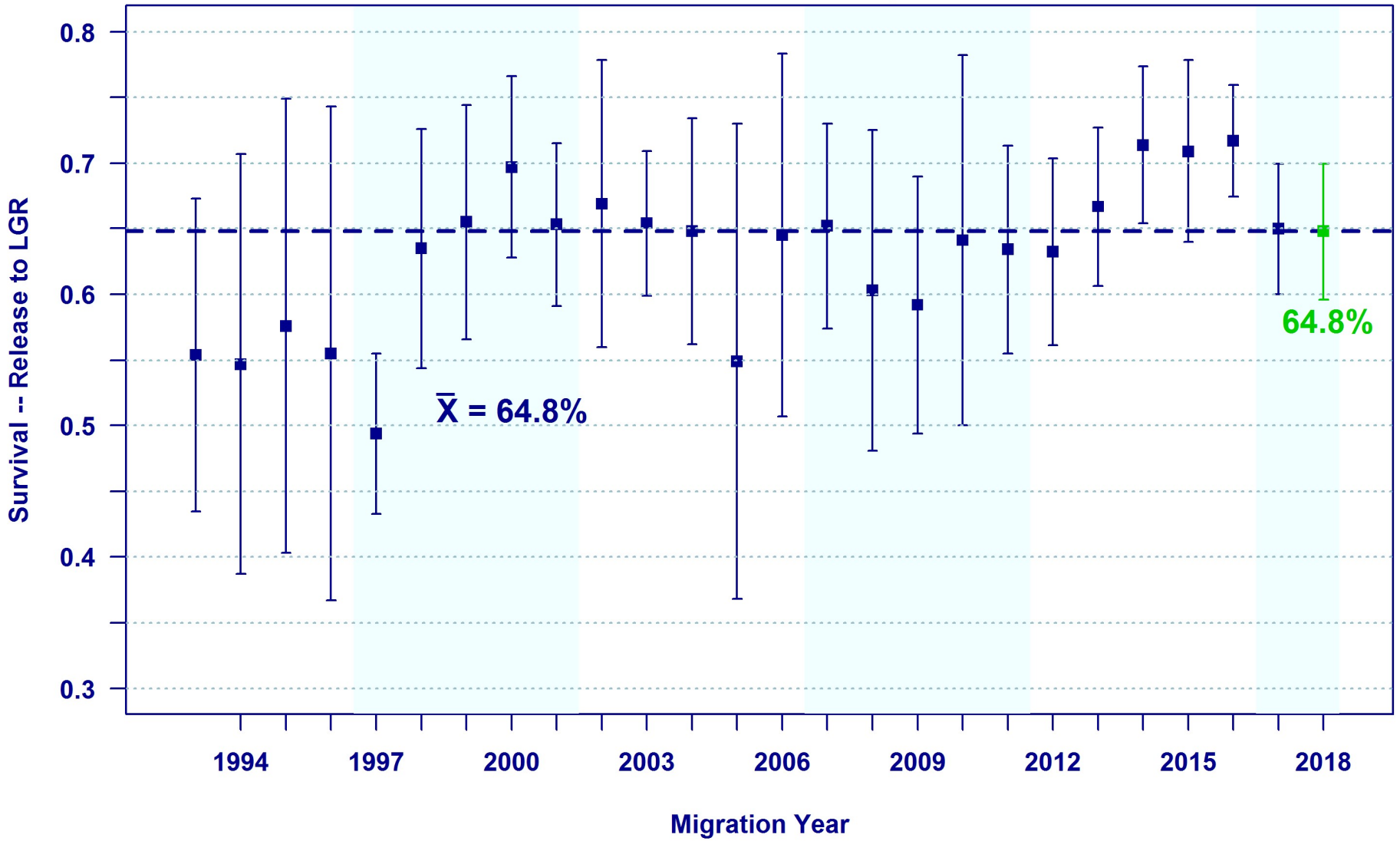
Steelhead Median Travel Time
Lower Granite to Bonneville (461 km)



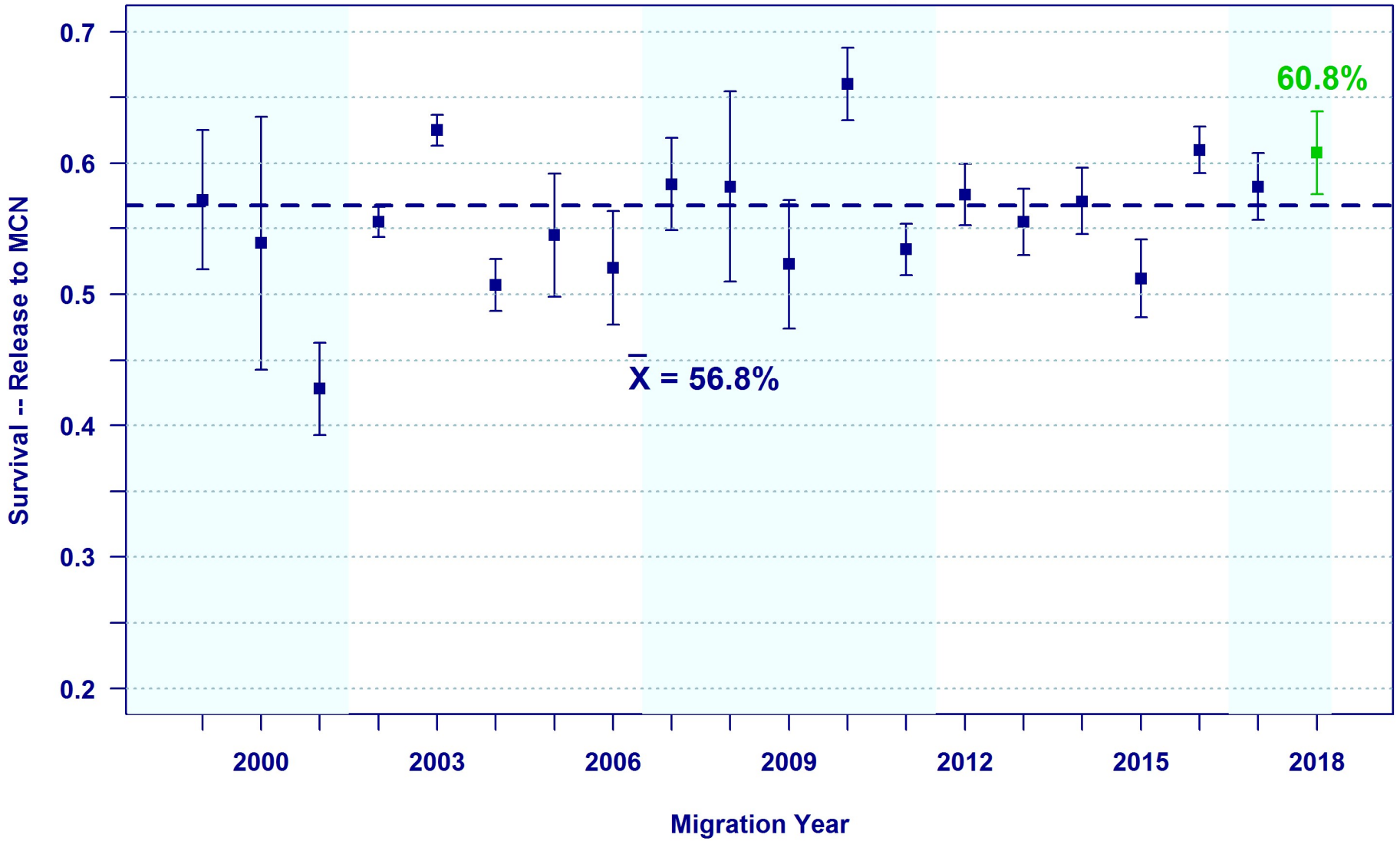
Steelhead Median Travel Time
Lower Granite to Bonneville (461 km)



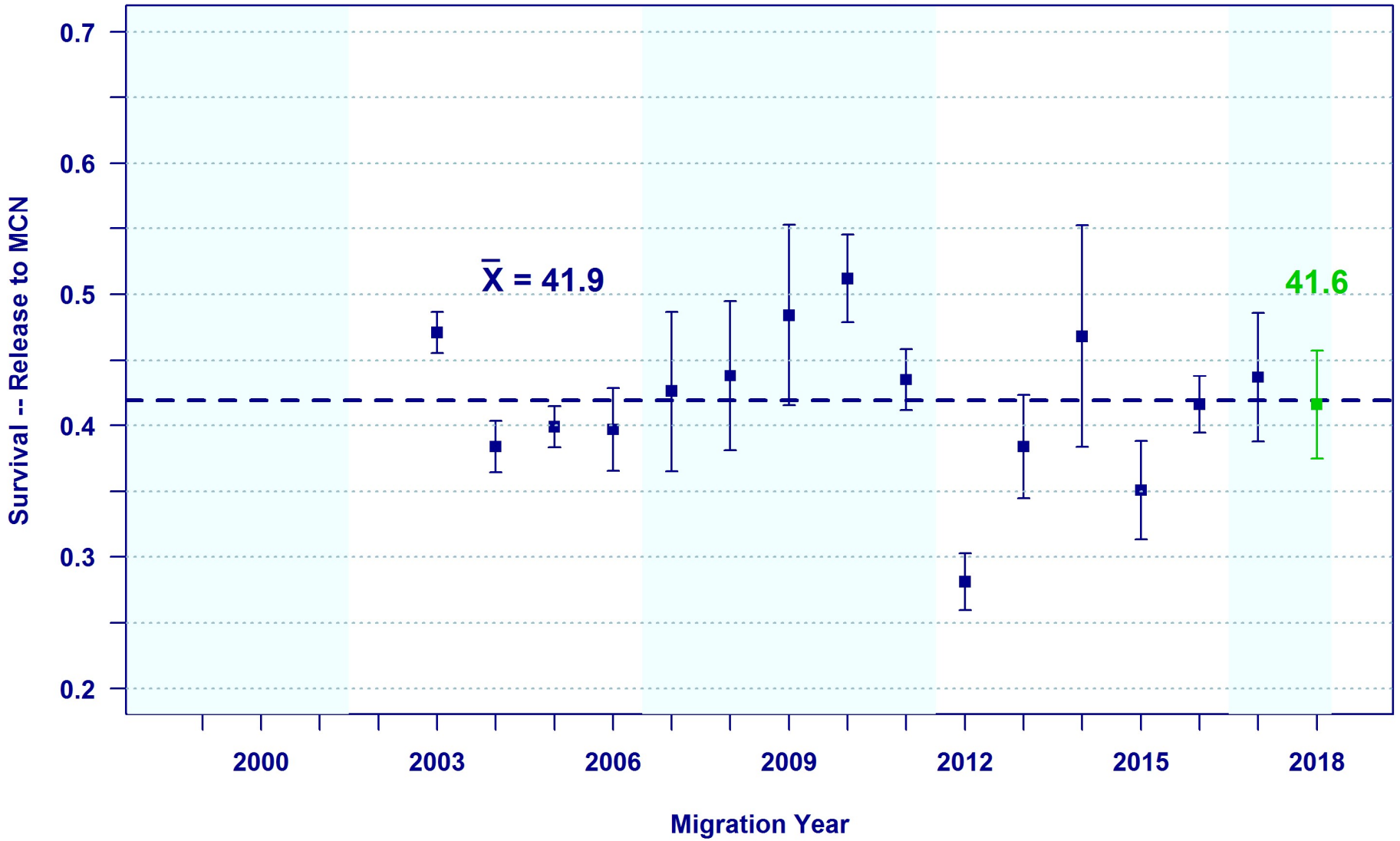
Yearling Chinook
Snake River Basin Hatcheries
Mean of Index Groups

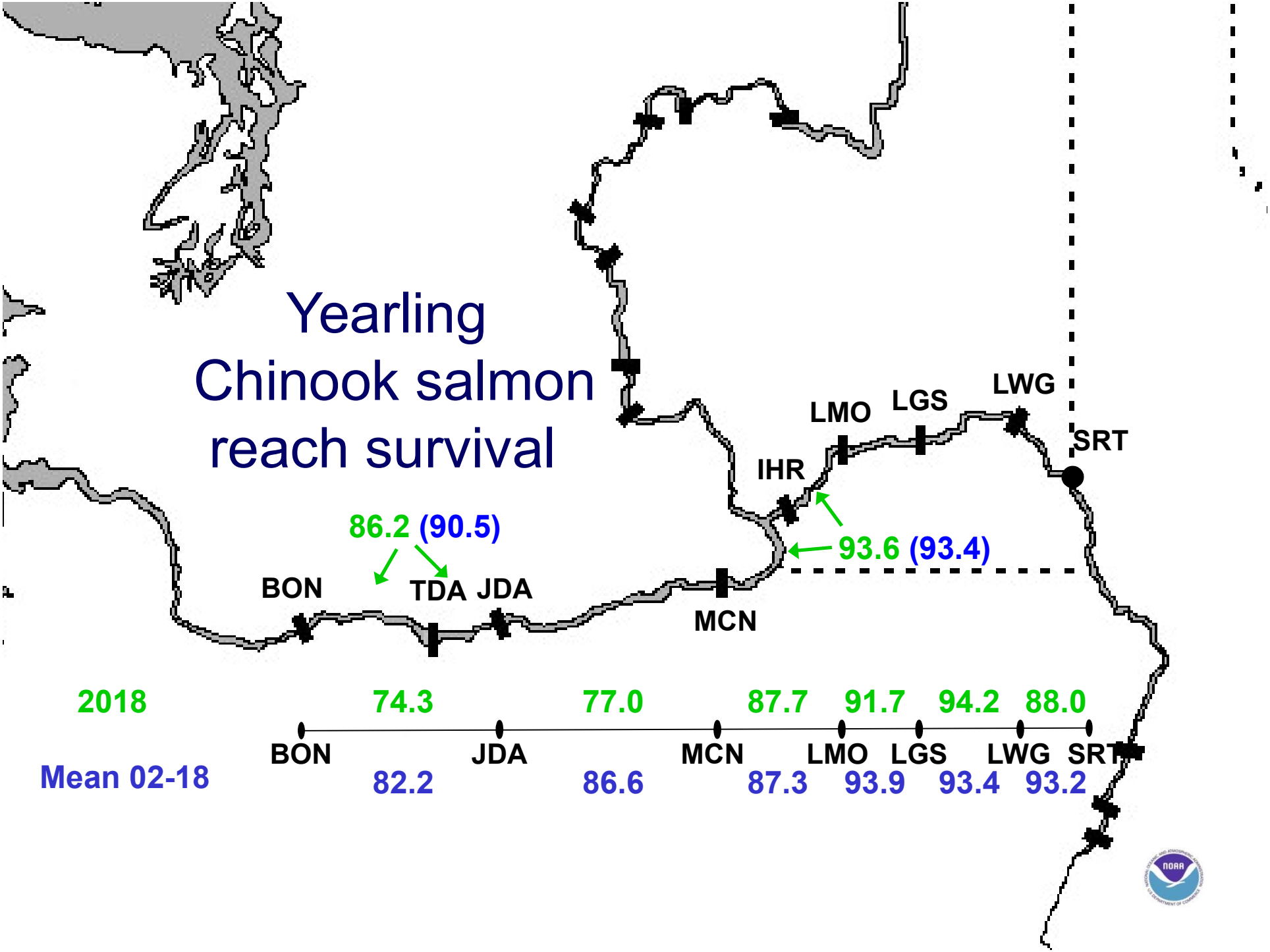


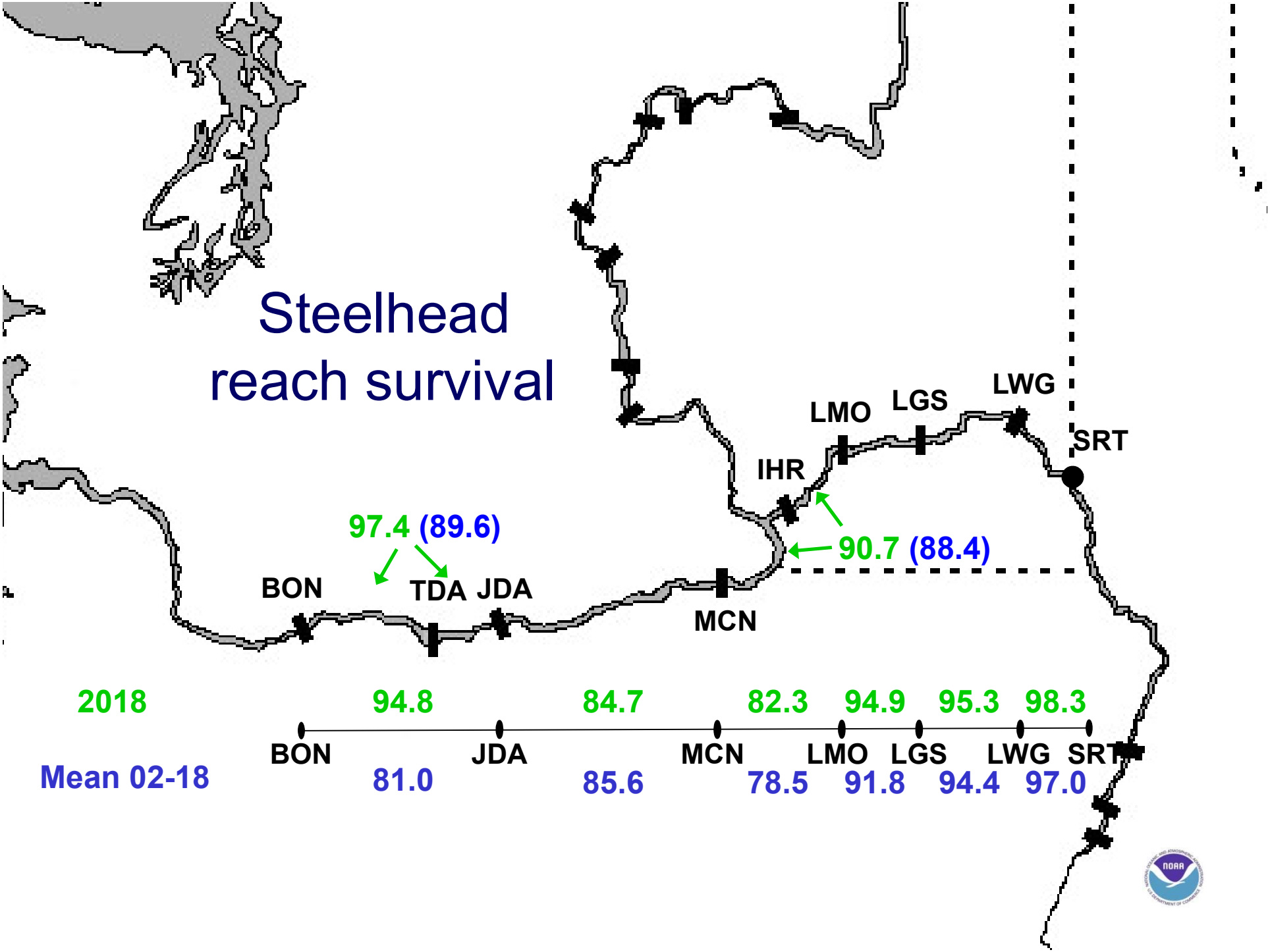
Yearling Chinook
Upper Columbia River Hatcheries
Mean of Index Groups

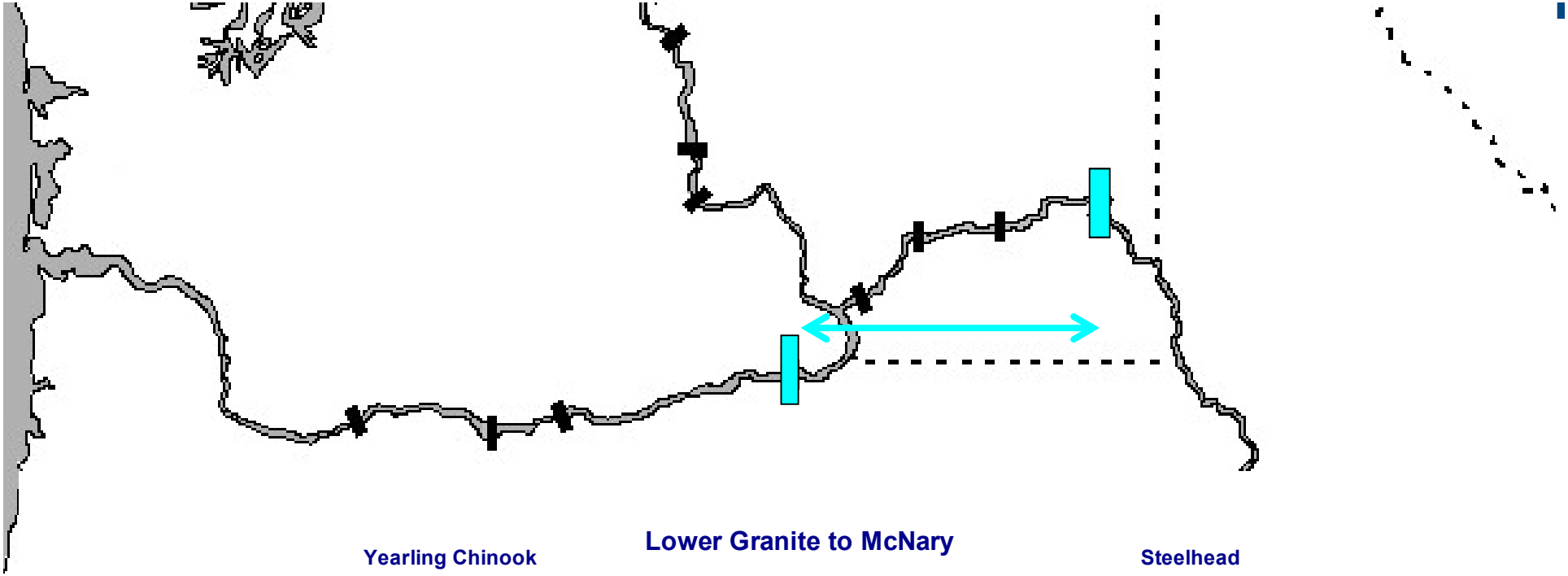


Steelhead
Upper Columbia River Hatcheries
Mean of Index Groups



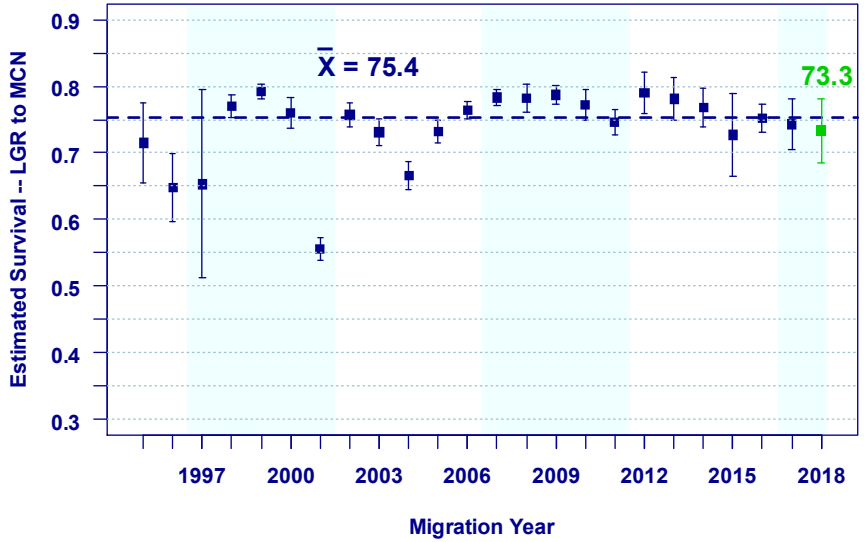

Yearling
Chinook salmon
reach survival
BON
TDA
JDA
MCN
IHR
LMO
LGS
LWG
SRT
86.2 (90.5)
93.6 (93.4)
2018
74.3
77.0
87.7
91.7
94.2
88.0
BON
JDA
MCN
LMO
LGS
LWG
SRT
Mean 02-18
82.2
86.6
87.3
93.9
93.4
93.2


Steelhead
reach survival
LWG
LGS
LMO
SRT
IHR
97.4 (89.6)
90.7 (88.4)
BON
TDA
JDA
MCN
2018
94.8
84.7
82.3
94.9
95.3
98.3
BON
JDA
MCN
LMO
LGS
LWG
SRT
Mean 02-18
81.0
85.6
78.5
91.8
94.4
97.0

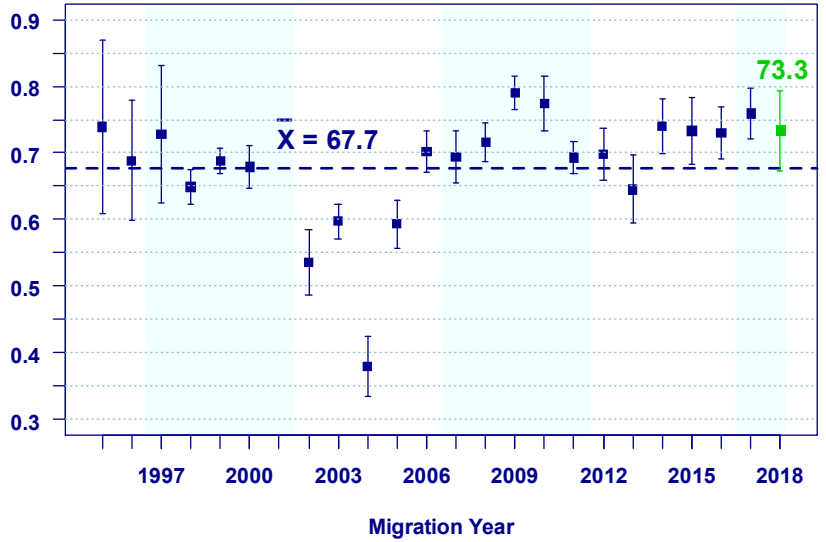


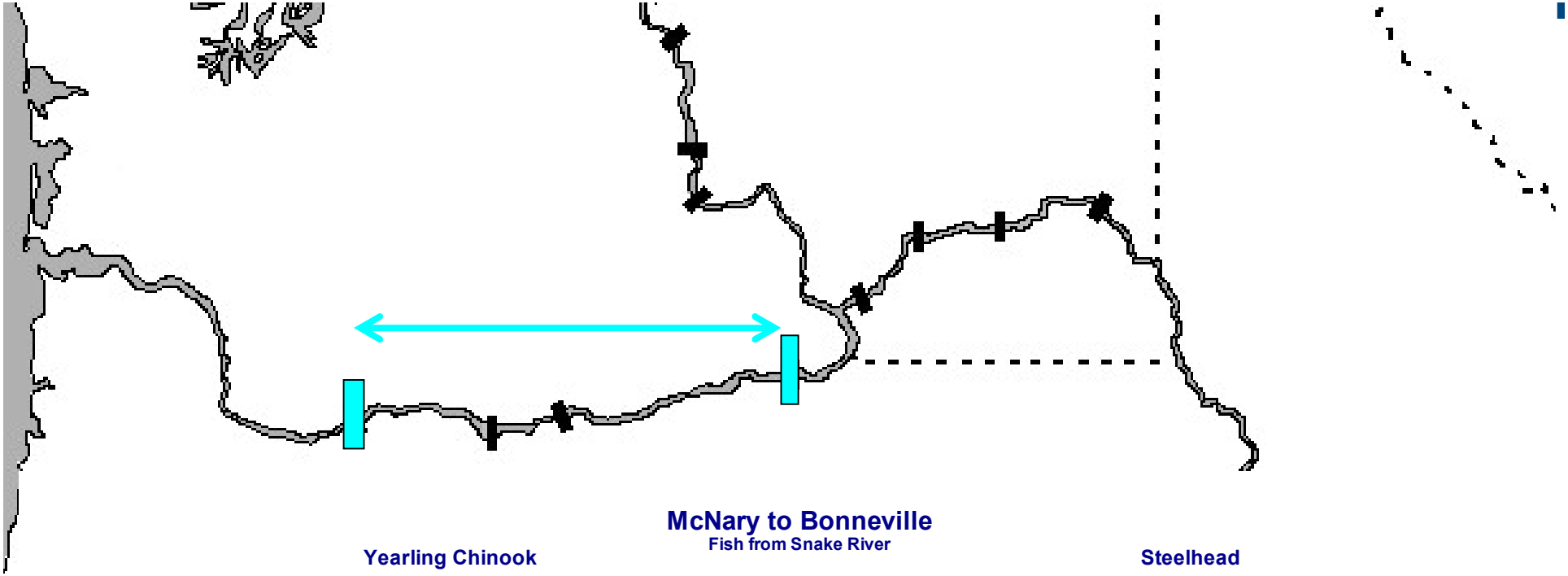
Lower Granite to McNary

Yearling Chinook



Steelhead

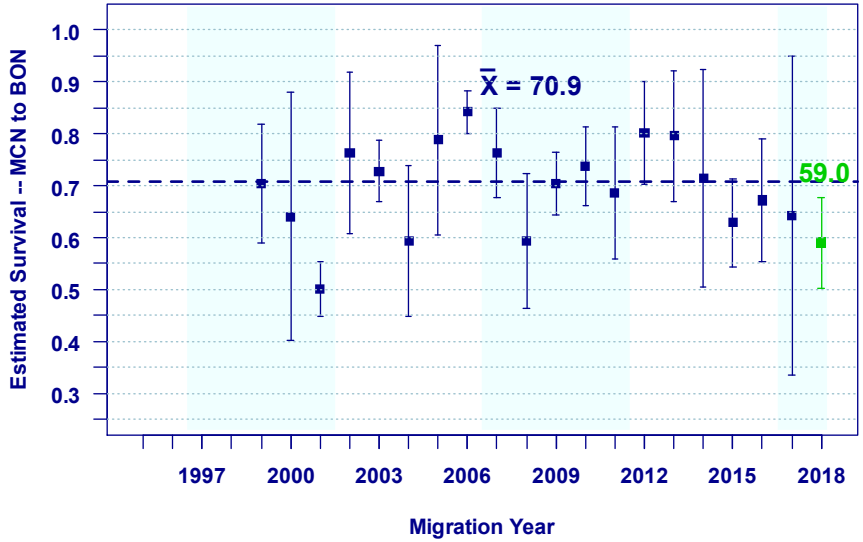




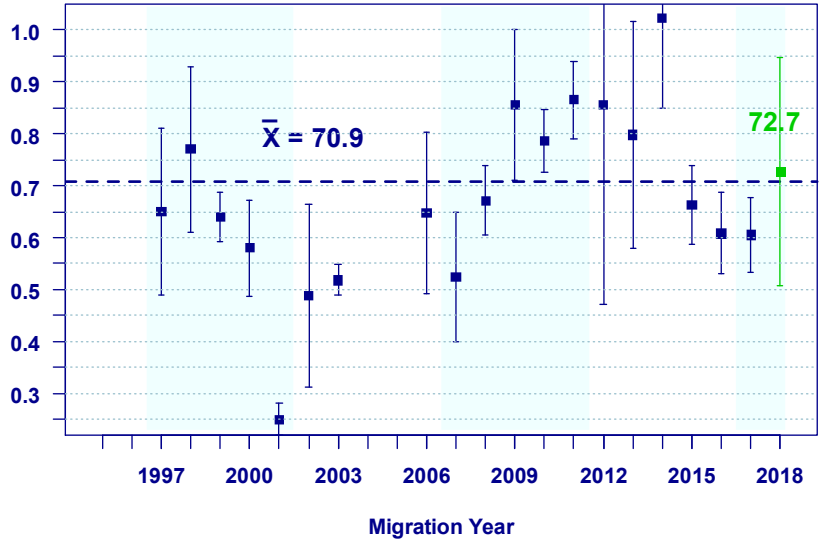
McNary to Bonneville

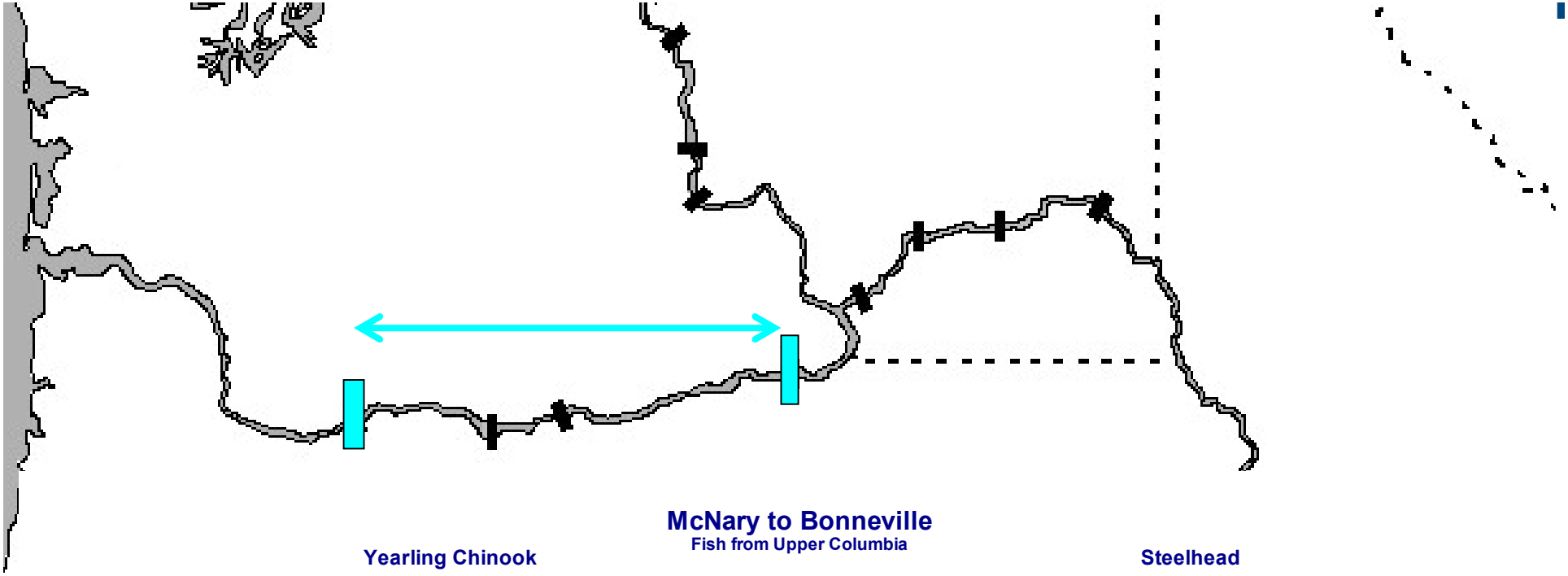
Fish from Snake River

Yearling Chinook



Steelhead

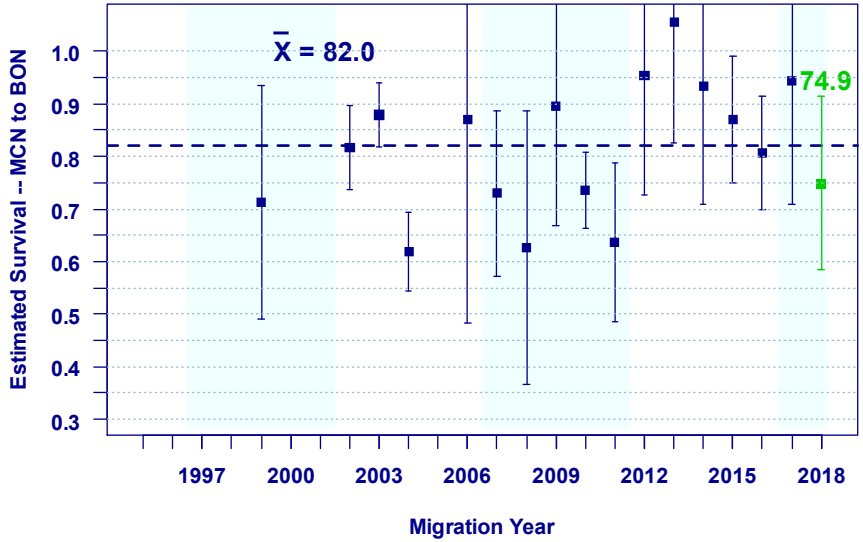




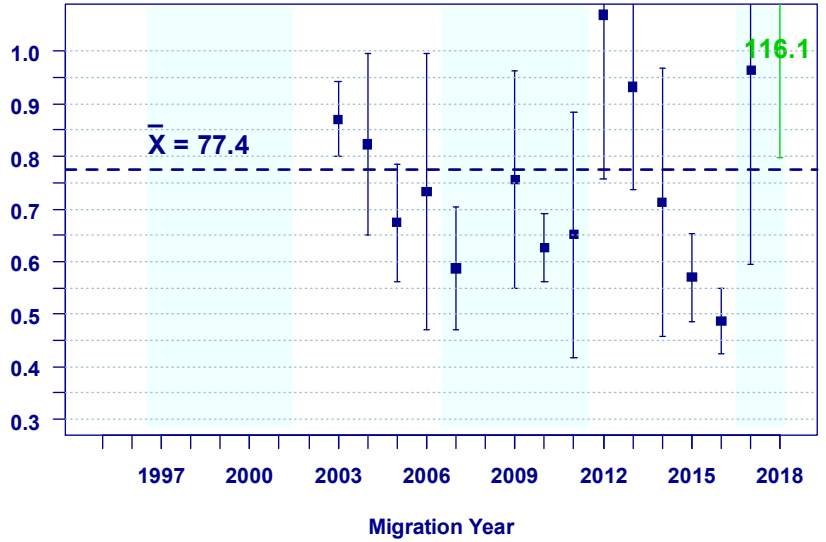
McNary to Bonneville

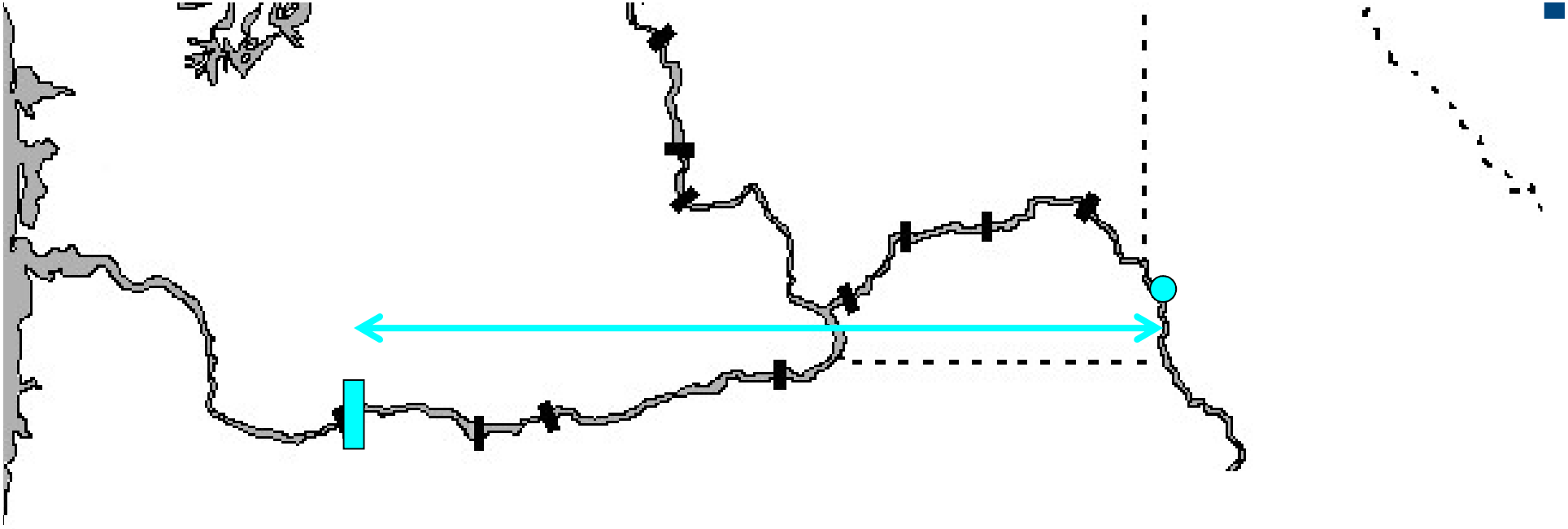
Fish from Upper Columbia

Yearling Chinook



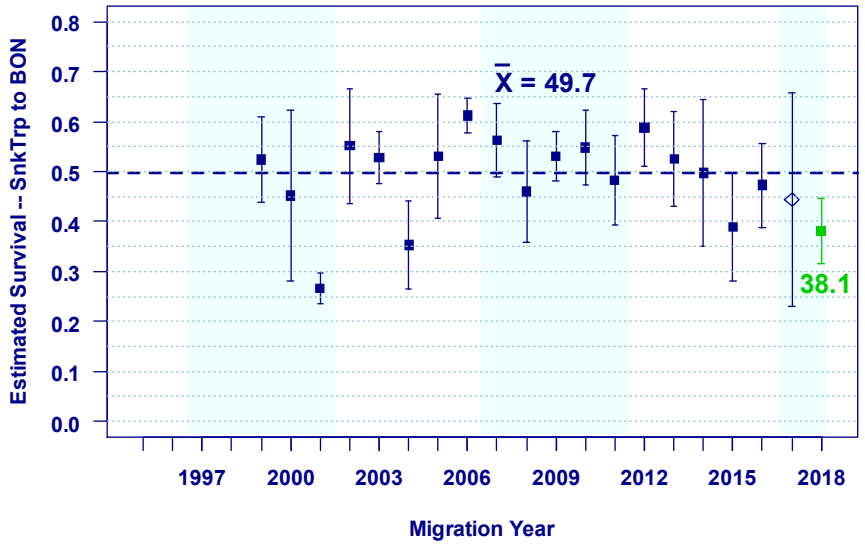
Steelhead



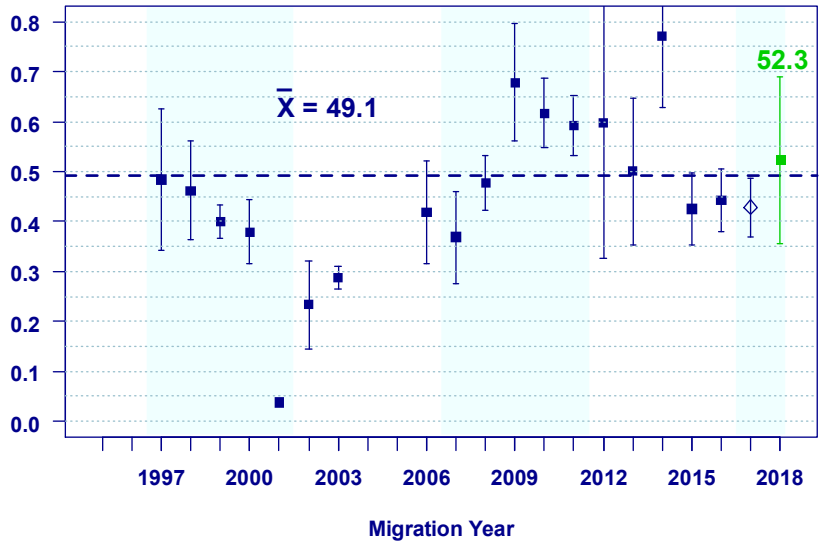


Snake River Trap to Bonneville

Yearling Chinook

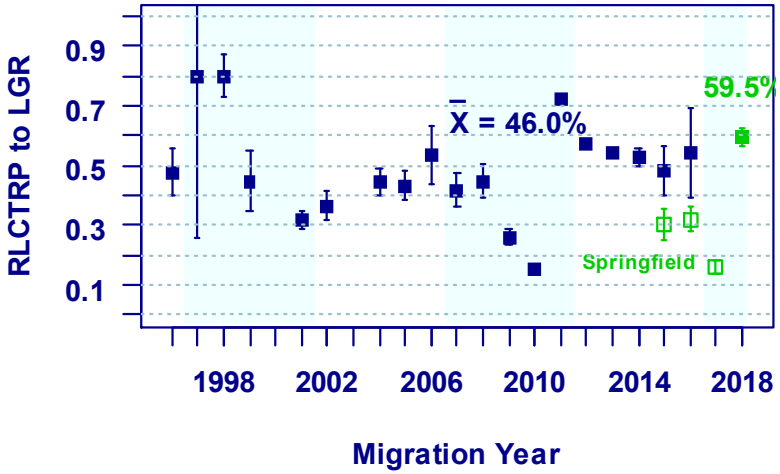


Steelhead

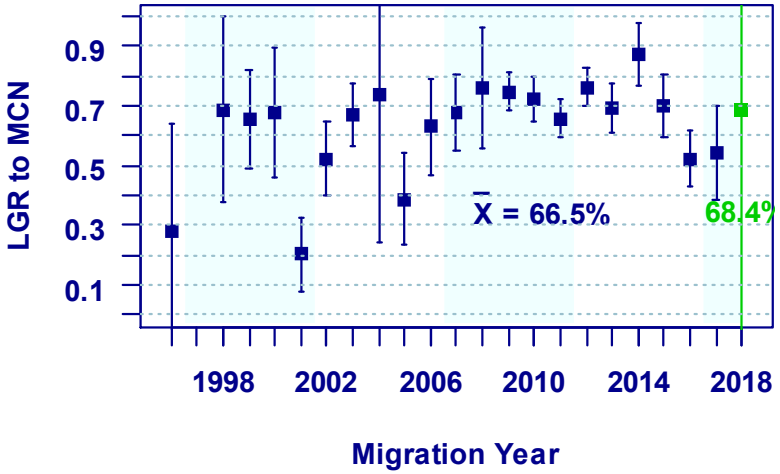


Snake River Sockeye: Estimated Survival

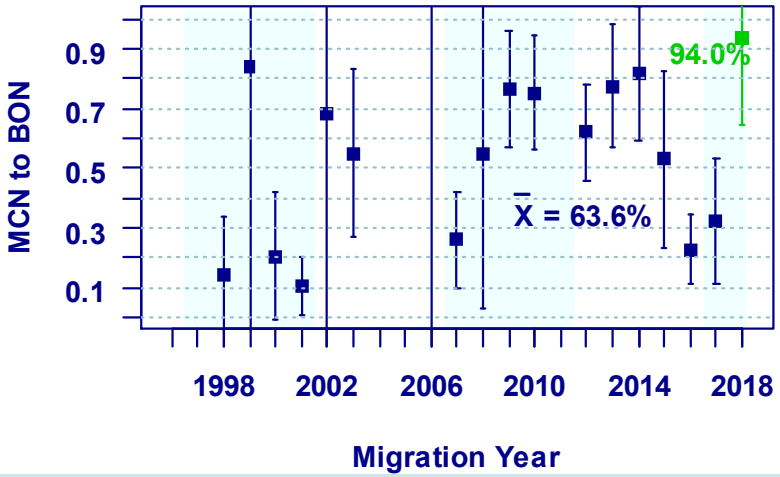
Redfish Lake Trap to Lower Granite



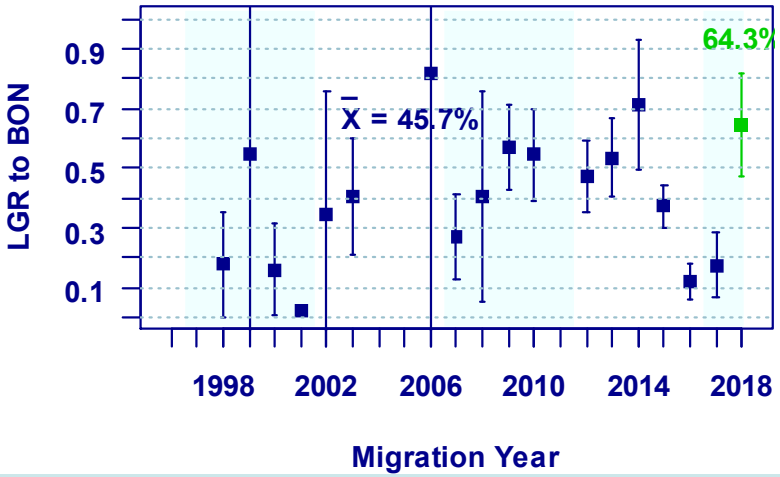
Lower Granite to McNary



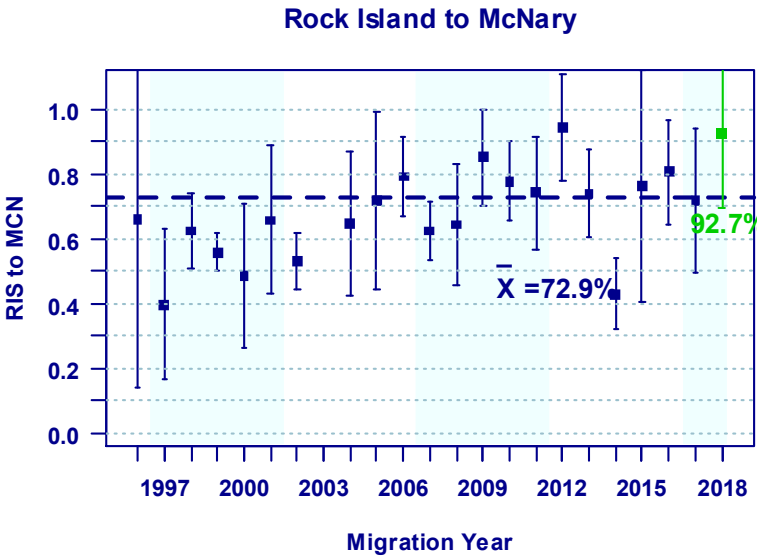
McNary to Bonneville

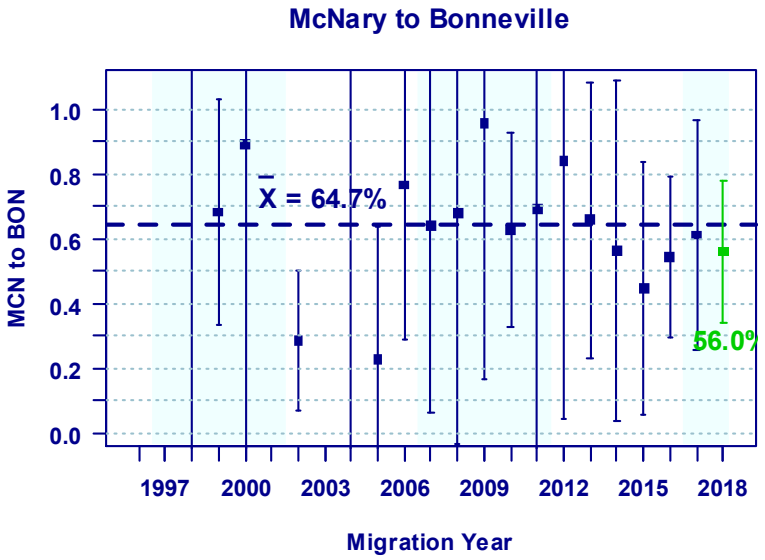


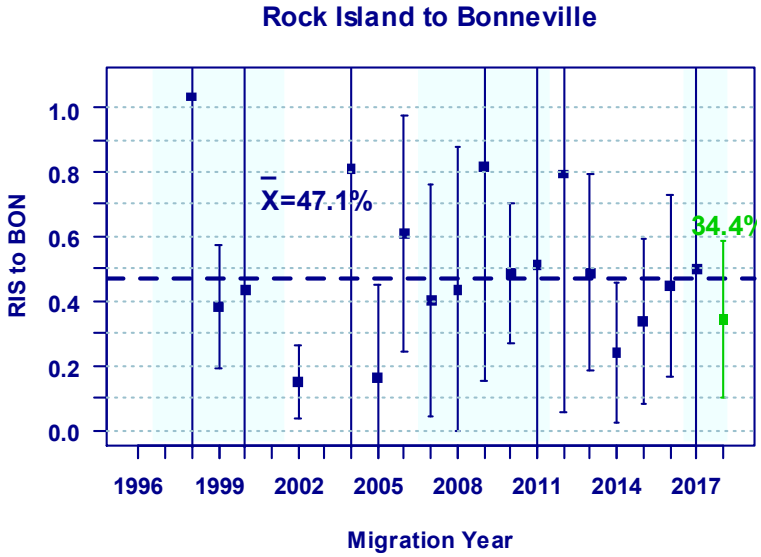
Lower Granite to Bonneville

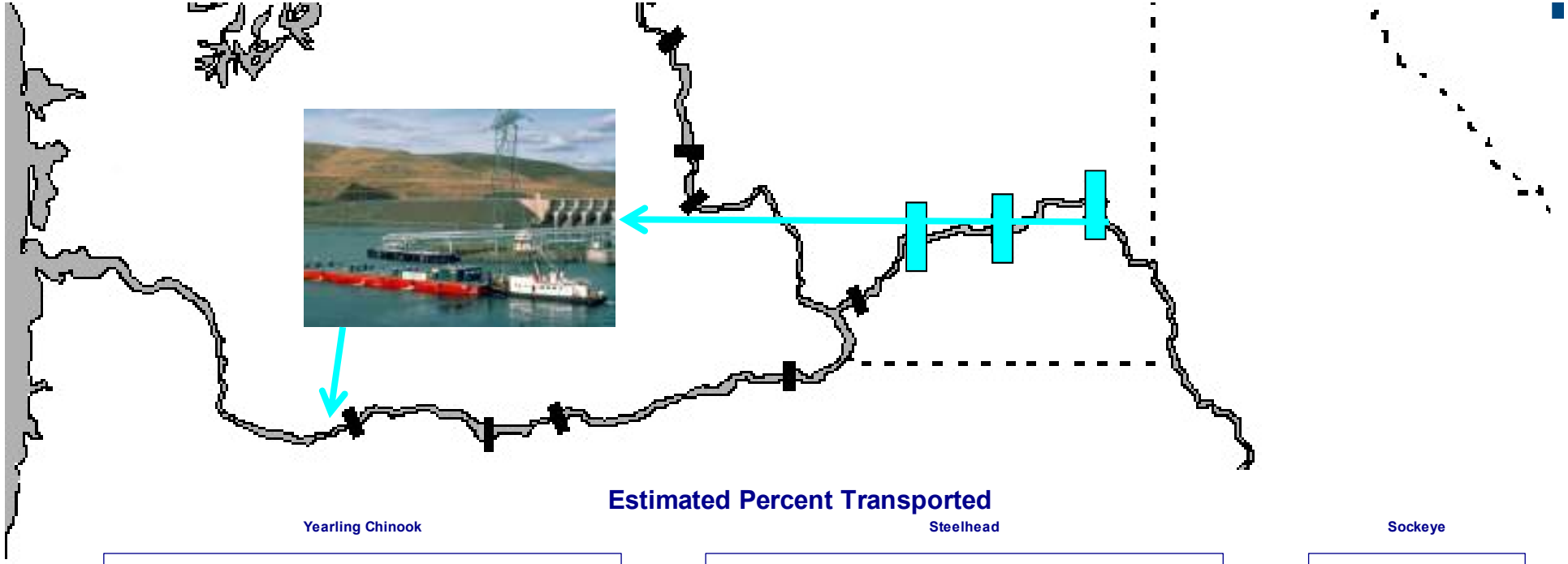


Columbia River Sockeye: Estimated Survival

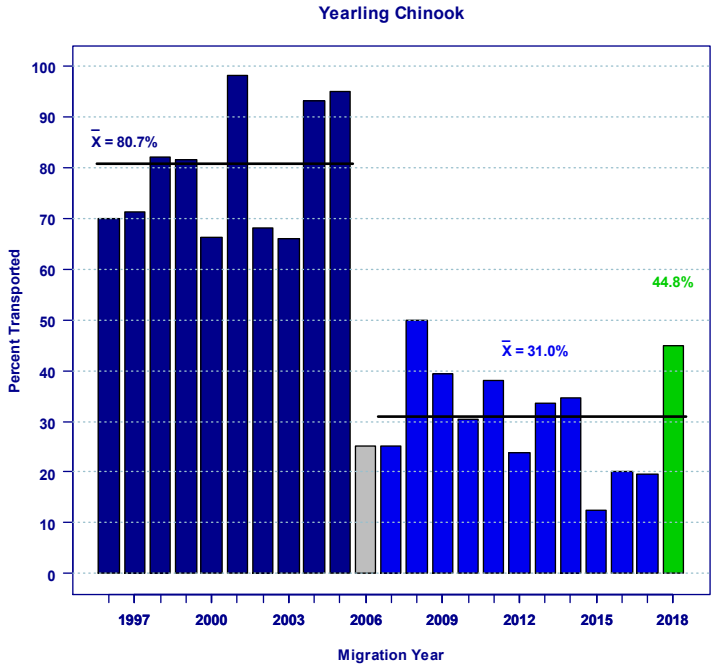


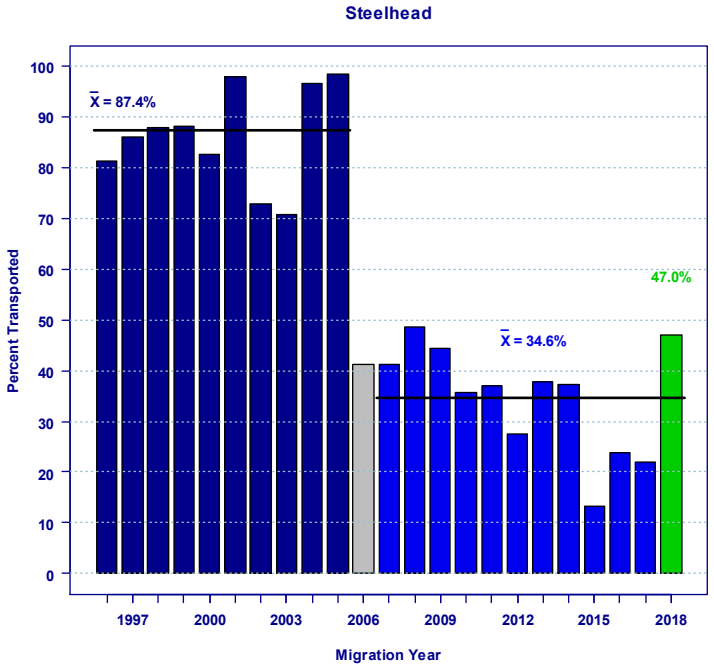


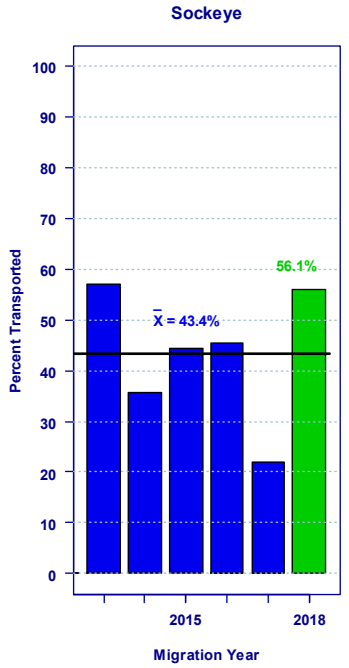




Estimated Percent Transported







Acknowledgments

- Bonneville Power Administration
- PTAGIS – Pacific States Marine Fisheries Commission
- DART – University of Washington Columbia Basin Research
- NOAA Colleagues: Jim Faulkner, Dan Widener
- Legions of Agencies, Coordinators, Taggers, ETC.


Questions

Smolt Transportation Seasonal Analyses

Yearling Chinook & Steelhead

Migration Years 2014-2016

- Updated with adult returns through Dec 16, 2018
- Added smolt migration year 2016
- Data from LGR, LGS, and LMN

Estimating Patterns of SAR vs. Date

- Need a “time-stamp” – date of passage/detection

- These analyses use fish that entered JBS at LWG, LGS, or LMN
  - tagged upstream of LWG or at LWG
  - either transported (T) or bypassed (B or “C1”)
  - can adjust “standards” based on observed C0 > C1
  - e.g.:

    if (C1/C0 = 1.1) then (T/C1 > 1.1) implies (T/C0 > 1)

Caveats: SAR regression analyses

- Analyses are:
  - Mostly based on available (adventitious) data
  - Restricted by dates of adventitious data
  - Descriptive of patterns in SARs through time within seasons
  - Based on in-river migrants that were bypassed (C1)
  - Subject to confounding of mortality and straying

  - NUMEROUS: 19 years x 4 species/rearing types x 3 dams =228 data sets

- Analyses are not:
  - Based on planned, designed experiments
  - Able to say much about transport in April, 2006-2014
  - Prescriptive for transport on particular dates or particular conditions
  - Based on non-bypassed in-river migrants (C0), because C0 date of passage is unknown
  - Able to determine effects of transport on straying

River Conditions

Migration Year	Flow	Spill%	Temperature
2014	Average	Average (~30%)	Slightly cooler
2015	Very low	High (30-50%)	Very warm
2016	Above average ("flat")	Average (~30%)	Warm

Zero Adult Counts

"If nothing goes right, is everything all wrong?"

- **Median Unbiased Estimator** of Binomial Probability

10 trials, no successes: MUE = 3.35%

100 trials, no successes: MUE = 0.345%

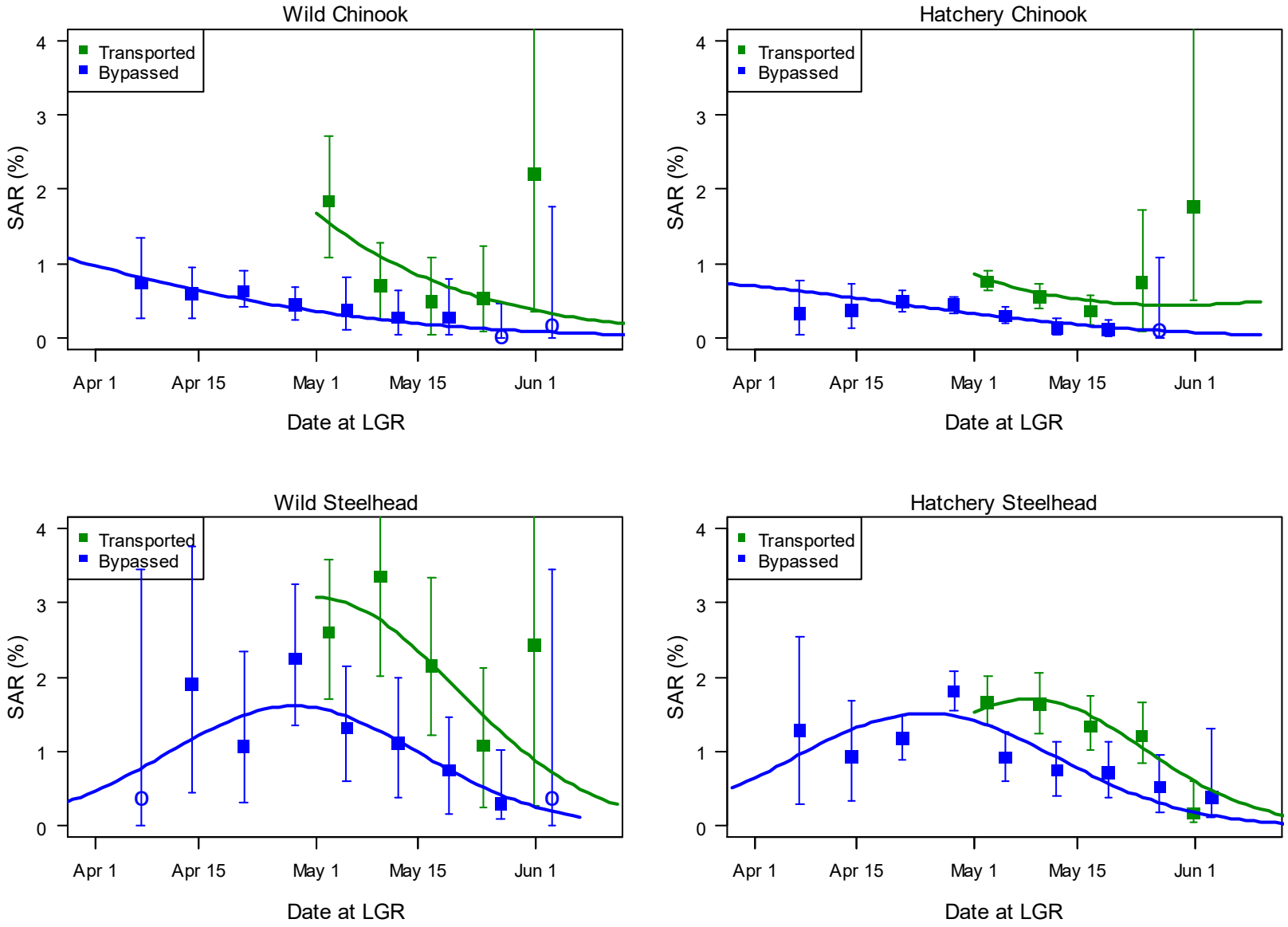
1000 trials, no successes: MUE = 0.0345%

HOWEVER, sum 3 weeks with 100 trials: 0/300 MUE = 0.115%

2014

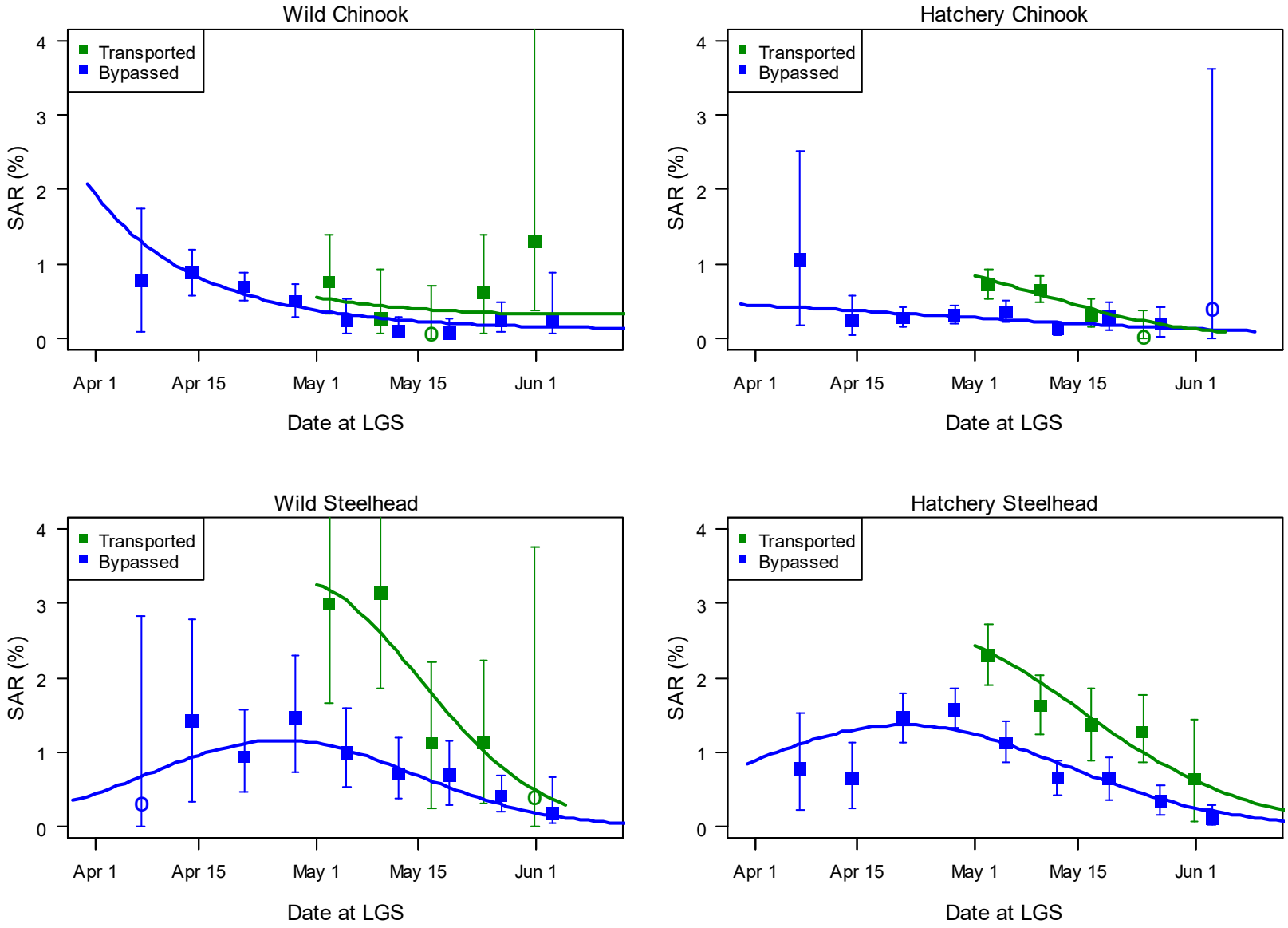
MY 2014

Transported or Bypassed at Lower Granite Dam



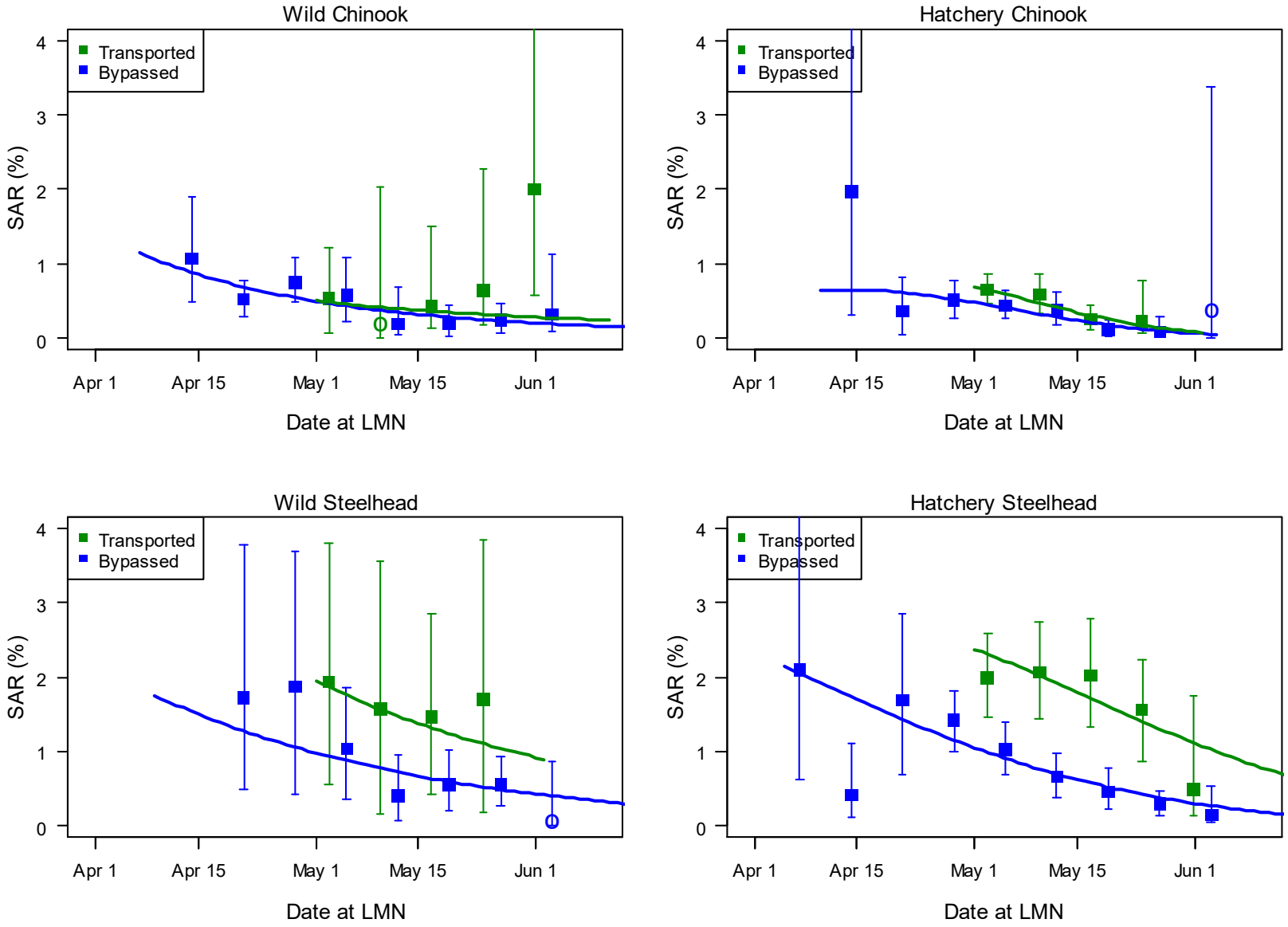
MY 2014

Transported or Bypassed at Little Goose Dam



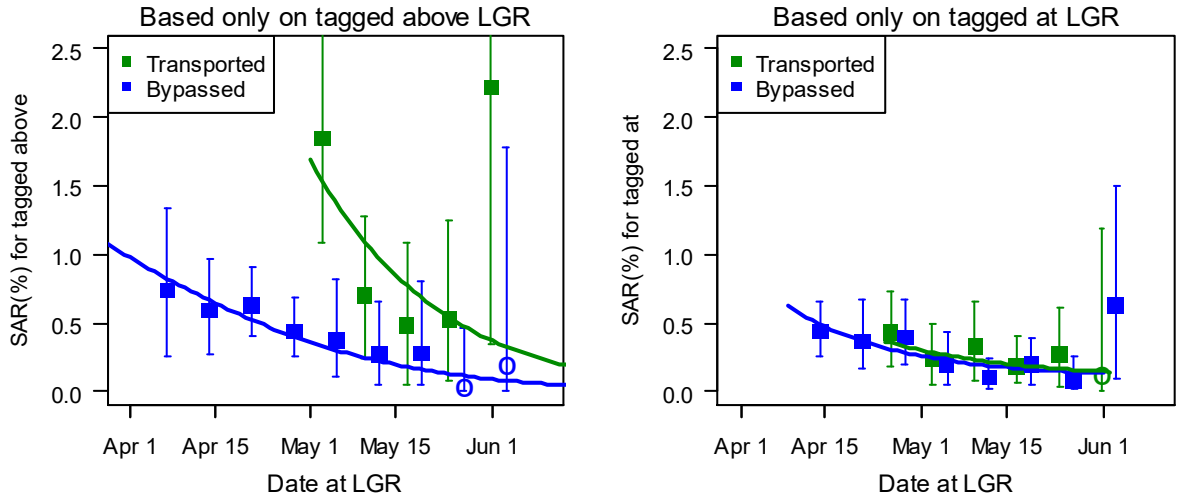
MY 2014

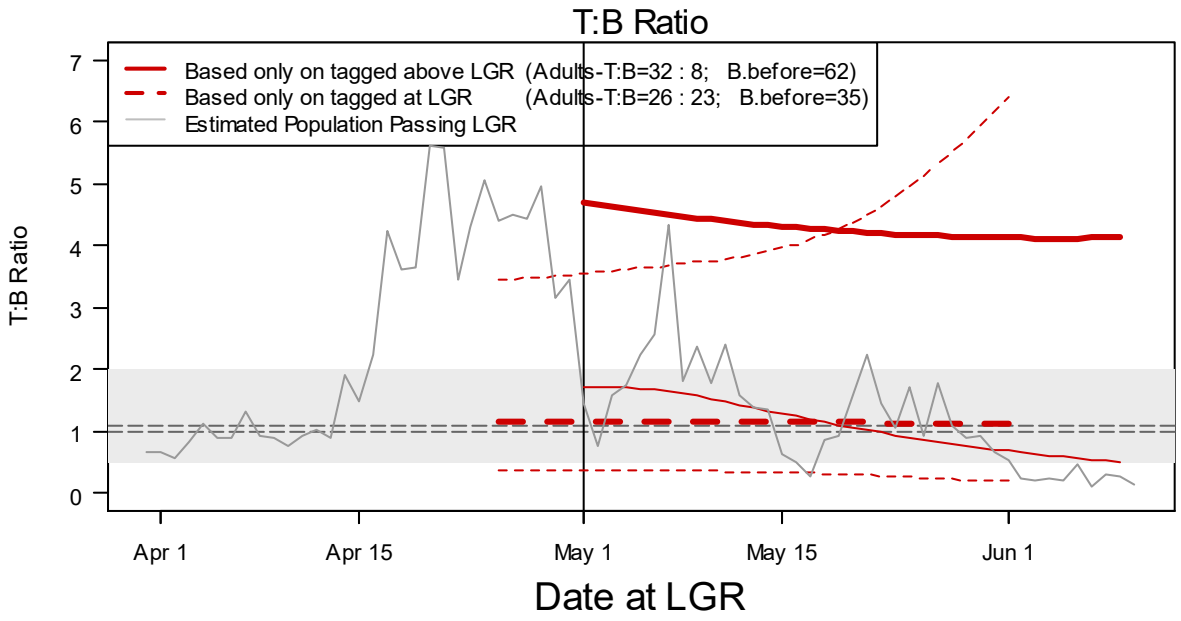
Transported or Bypassed at Lower Monumental Dam



Wild Chinook 2014

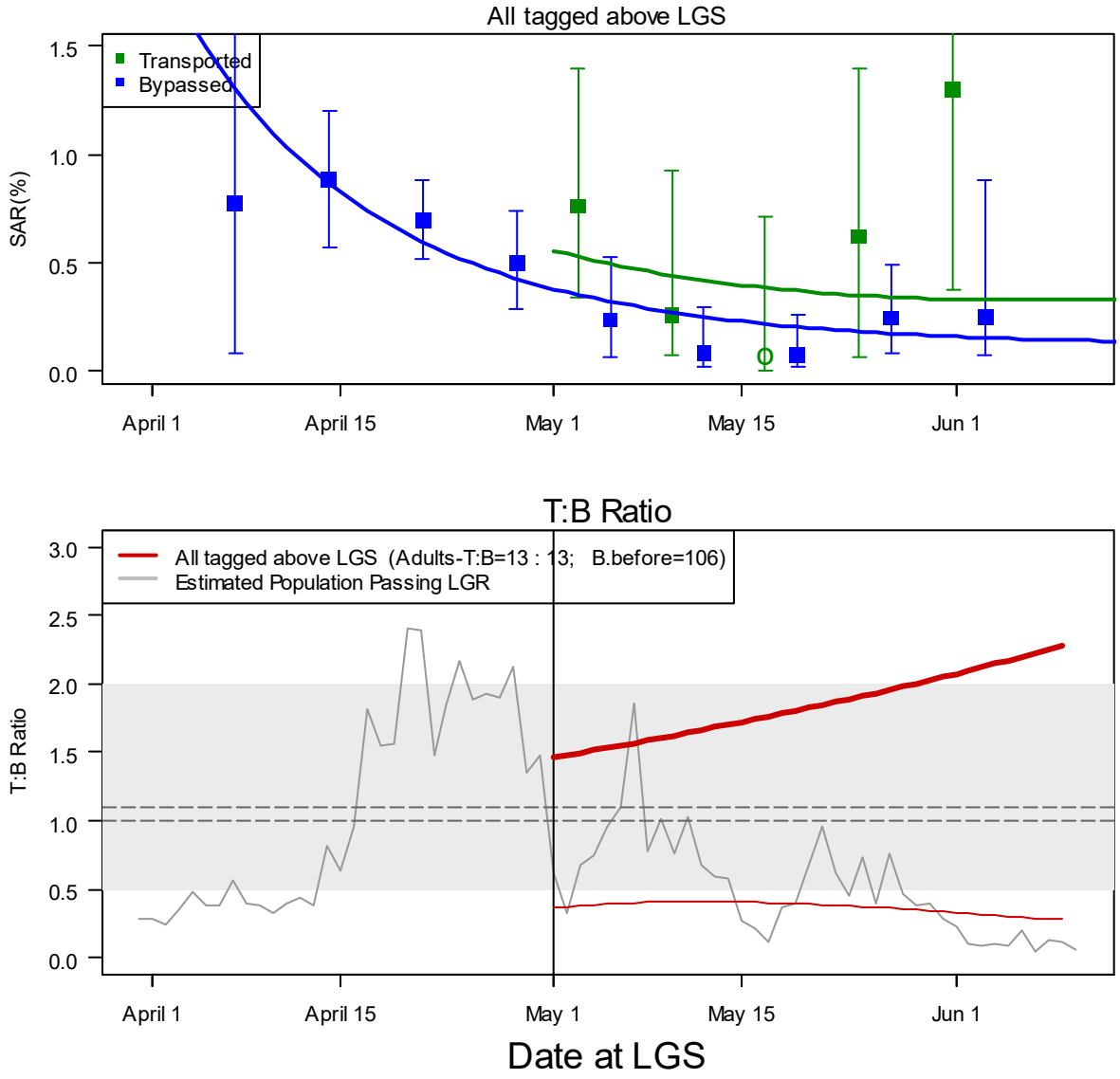
Transported or Bypassed at Lower Granite Dam





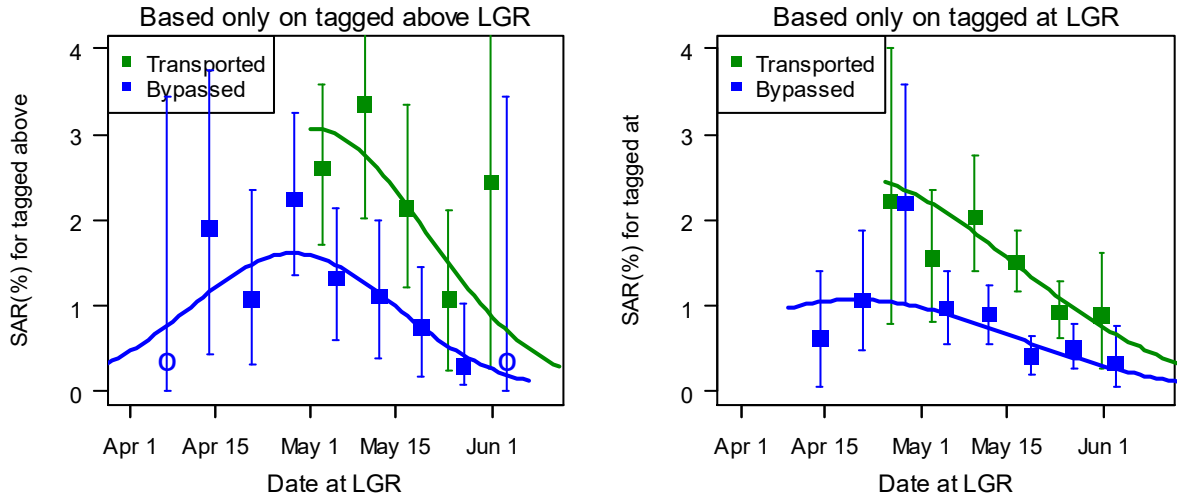
Wild Chinook 2014

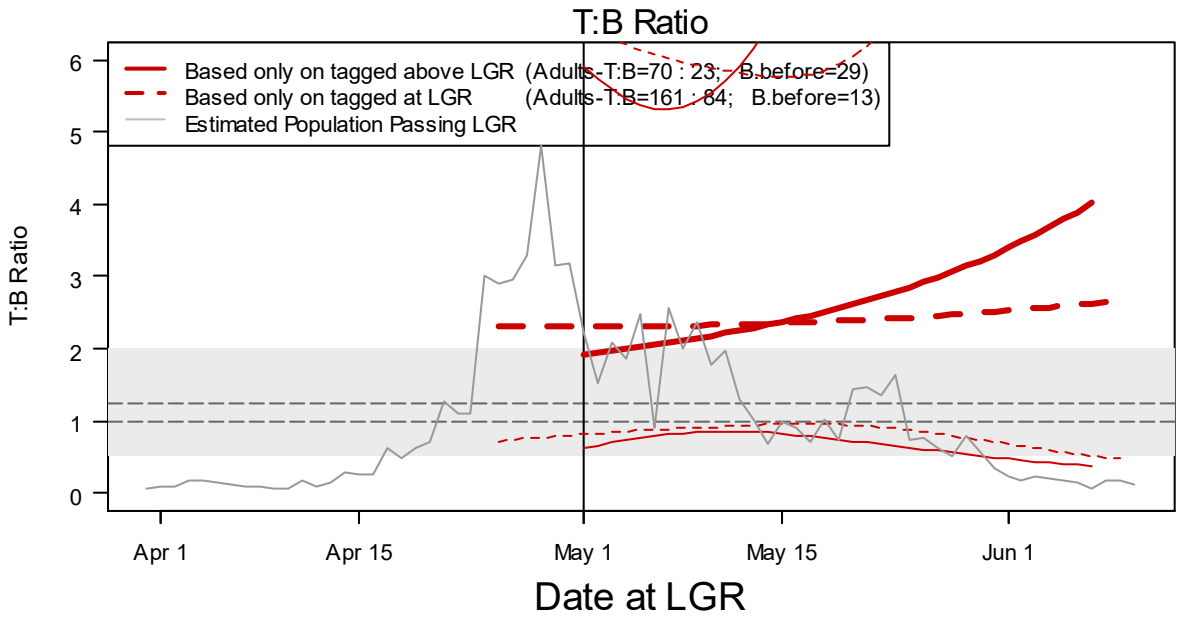
Transported or Bypassed at Little Goose Dam



Wild Steelhead 2014

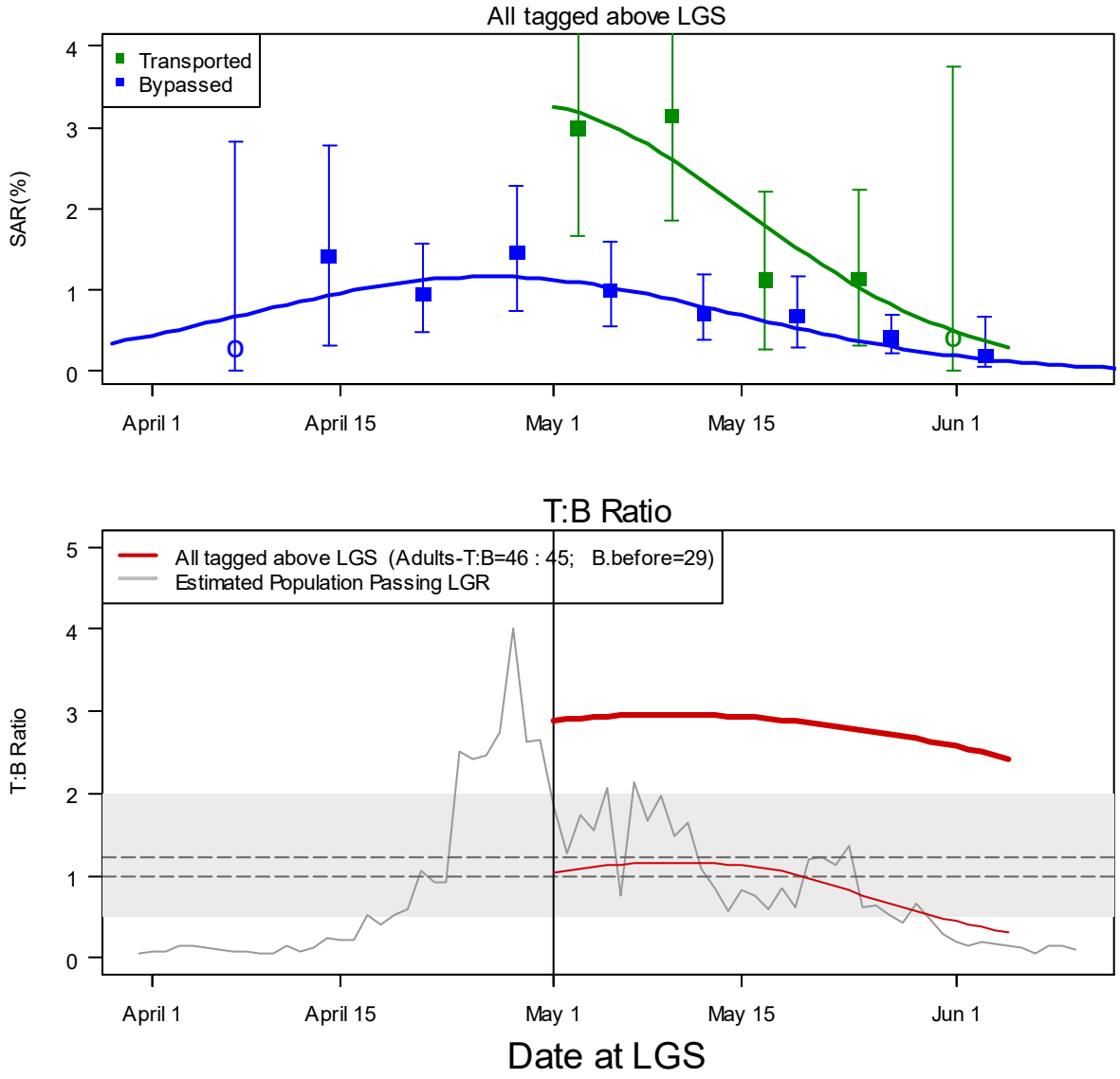
Transported or Bypassed at Lower Granite Dam





Wild Steelhead 2014

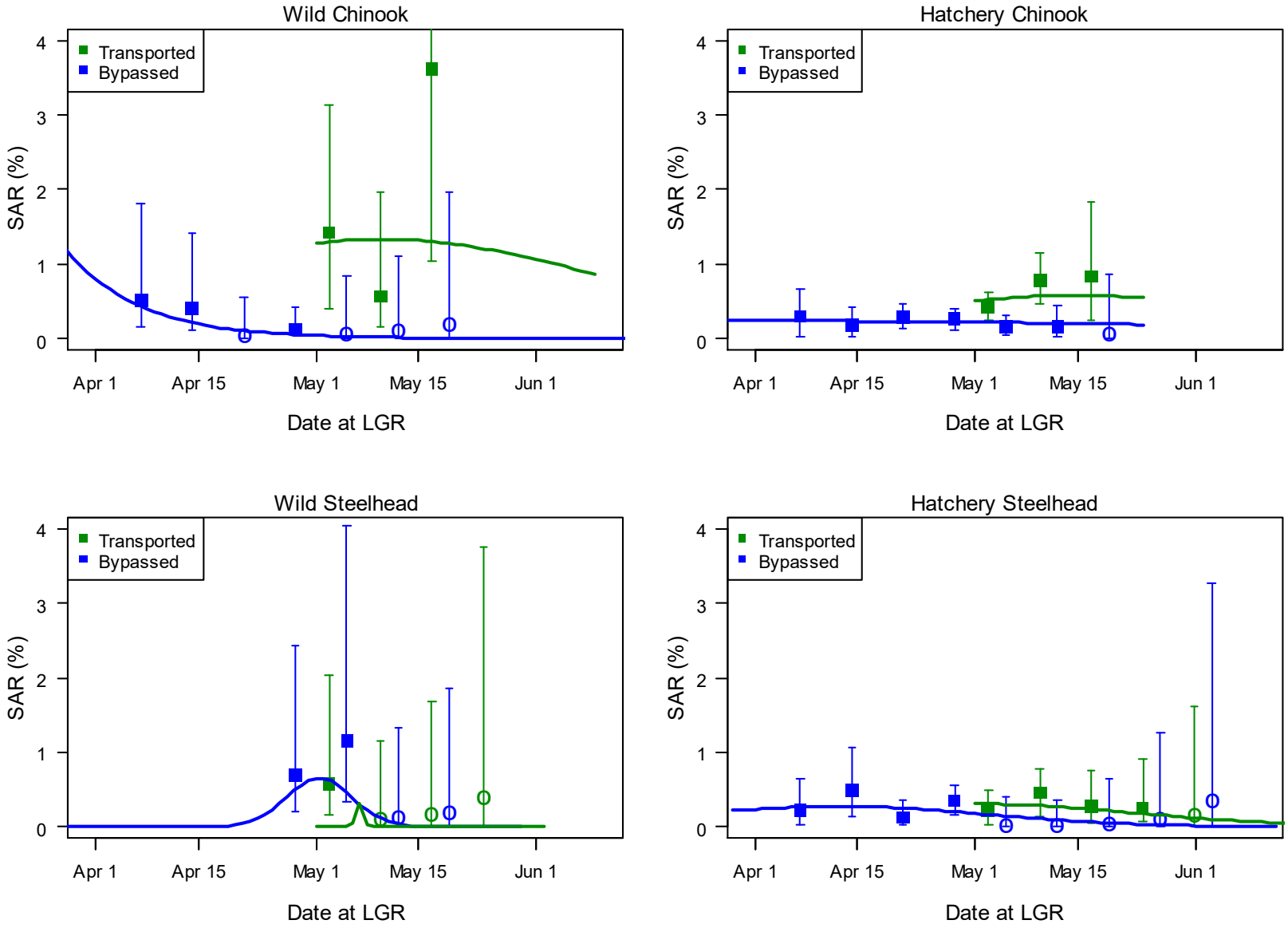
Transported or Bypassed at Little Goose Dam



2015

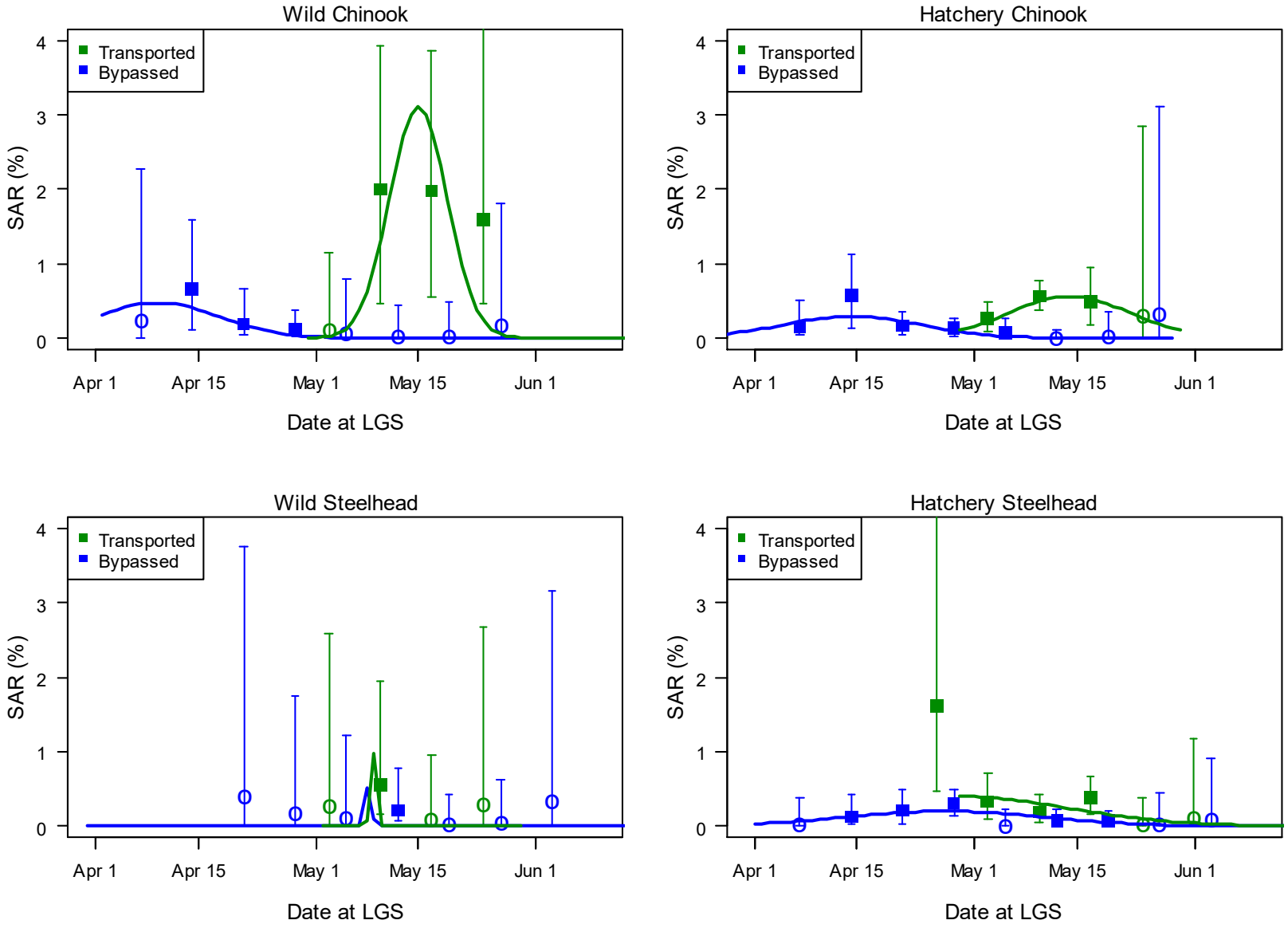
MY 2015

Transported or Bypassed at Lower Granite Dam



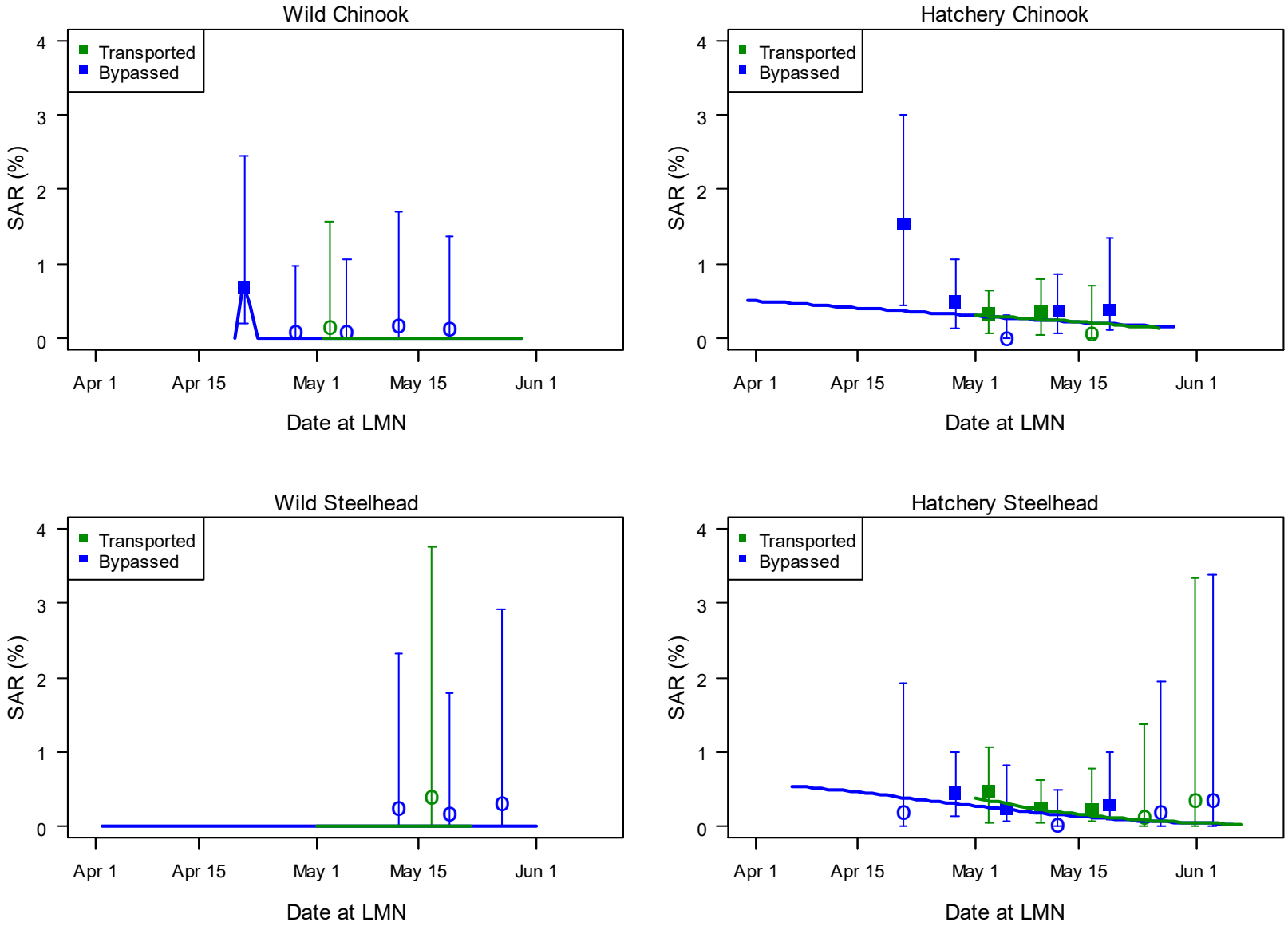
MY 2015

Transported or Bypassed at Little Goose Dam



MY 2015

Transported or Bypassed at Lower Monumental Dam



Lower Granite Dam
Totals for May 1 – June 4, 2015

Wild Chinook						Wild Steelhead			
	Juv	Adt	SAR	CI		Juve	Adt	SAR	CI
Transport	680	9*	1.35	0.61-2.38		748	1	0.16	0.05-0.56
Bypassed	873	0	0.04	0.00-0.34		580	1	0.20	0.06-0.72
T:B Ratio			34.0	4.8 – 56.2		T:B Ratio		0.78	0.08-7.10

* 1 adult returned in 2018

Little Goose Dam
Totals for May 1 – June 4, 2015

Wild Chinook						Wild Steelhead			
	Juv	Adt	SAR	CI		Juve	Adt	SAR	CI
Transport	829	10*	1.23	0.62-1.95		755	1	0.16	0.05-0.55
Bypassed	2110	1	0.06	0.02-0.20		801	1	0.15	0.04-0.52
T:B Ratio			21.8	5.0-104.0		T:B Ratio		1.06	0.12-9.71

* 1 adult returned in 2018

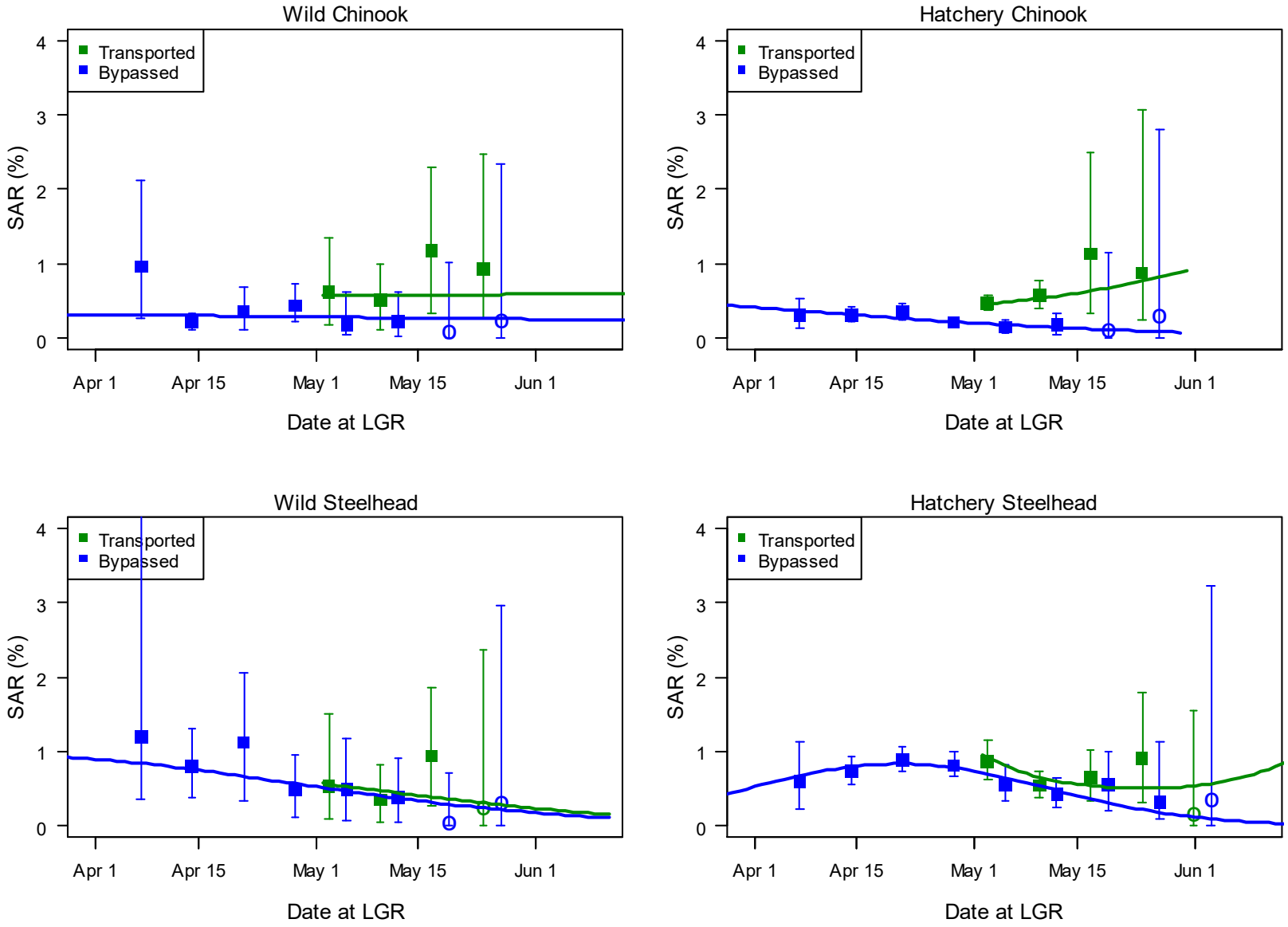
Lower Monumental Dam
Totals for May 1 – June 4, 2015

Wild Chinook						Wild Steelhead			
	Juv	Adt	SAR	CI		Juve	Adt	SAR	CI
Transport	333	0	0.10	0-0.90		224	0	0.15	0-1.34
Bypassed	758	0	0.05	0-0.40		190	0	0.18	0-1.58
T:B Ratio			NA	NA		T:B Ratio		NA	NA

2016

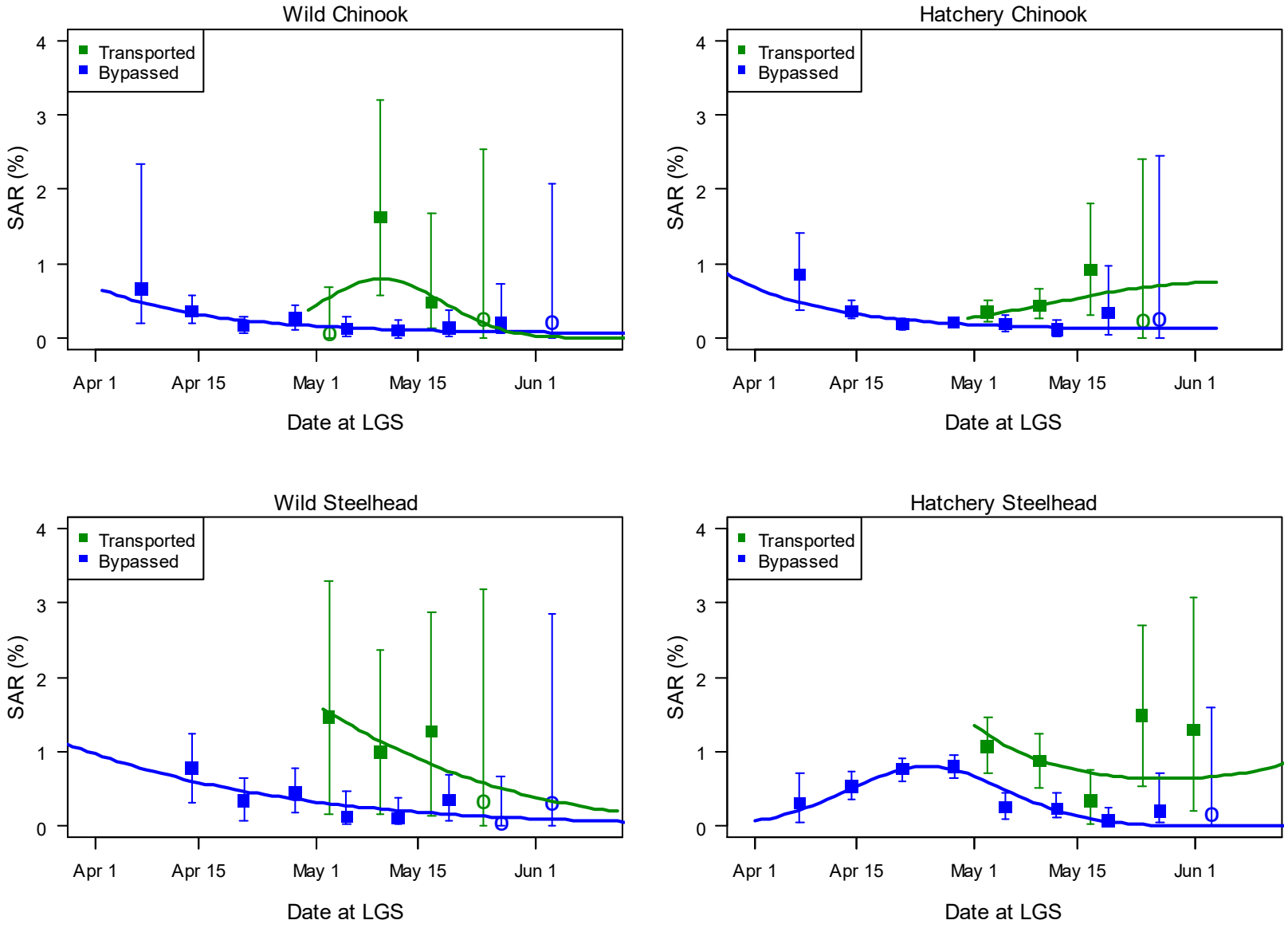
MY 2016

Transported or Bypassed at Lower Granite Dam



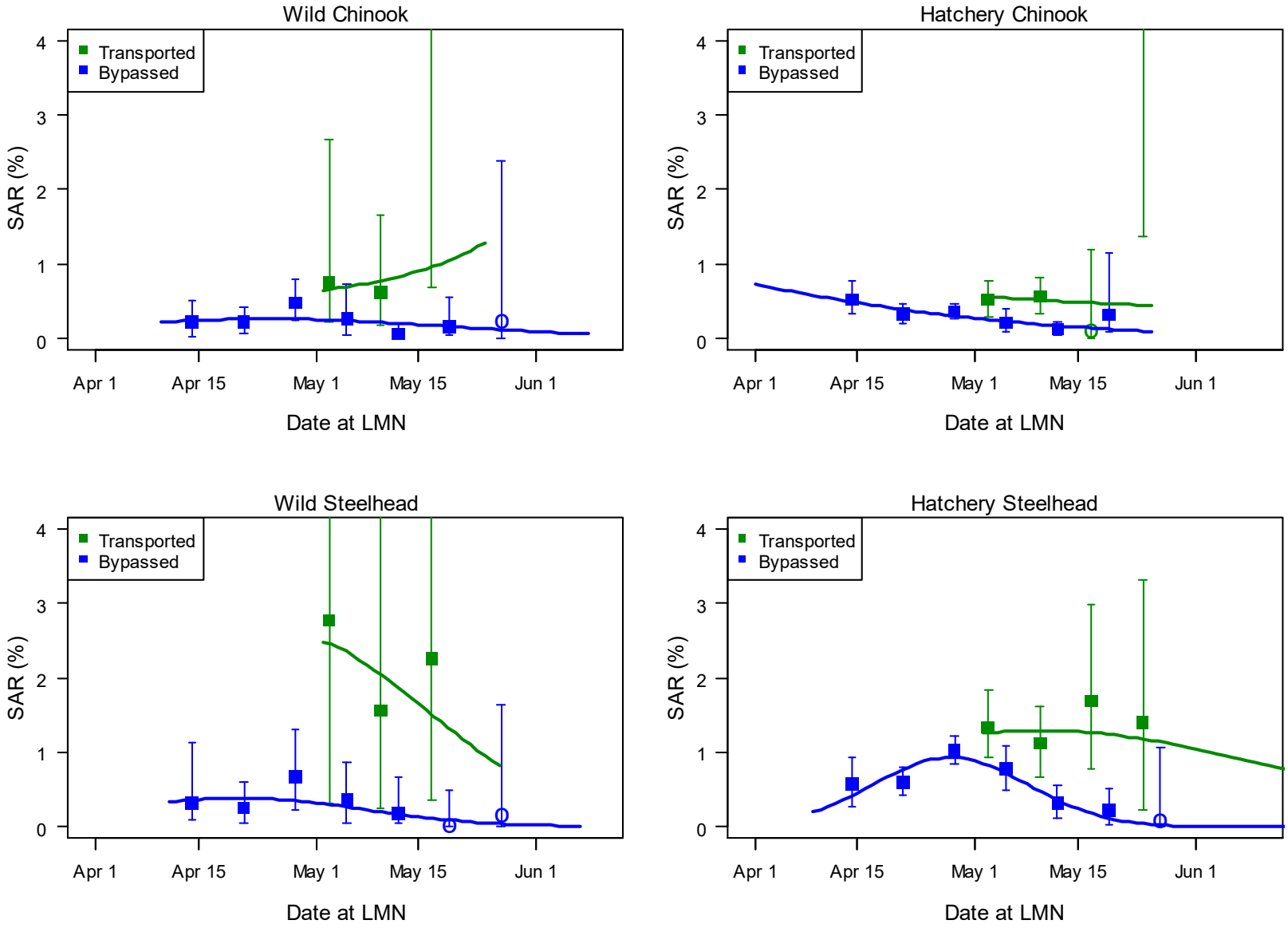
MY 2016

Transported or Bypassed at Little Goose Dam



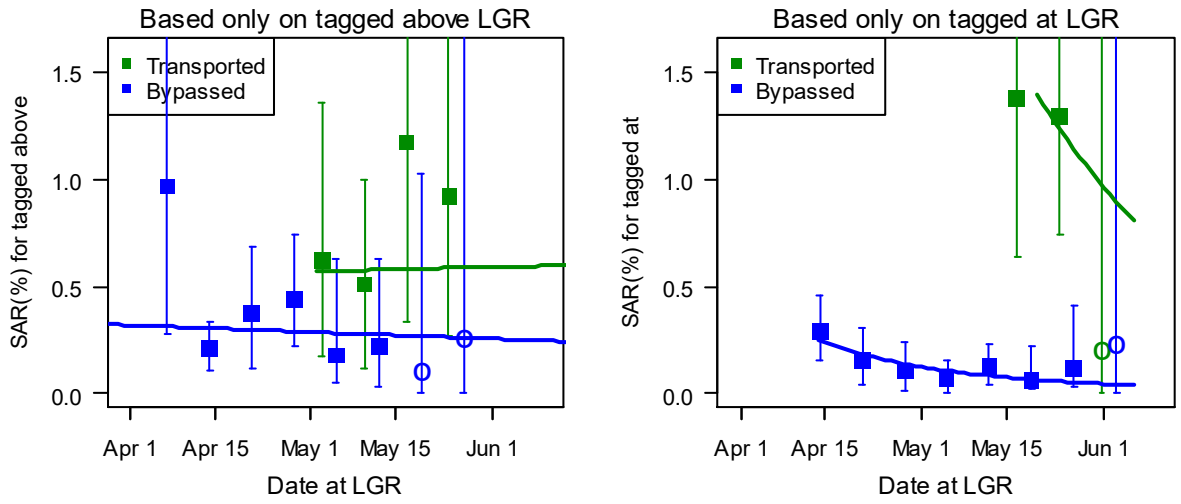
MY 2016

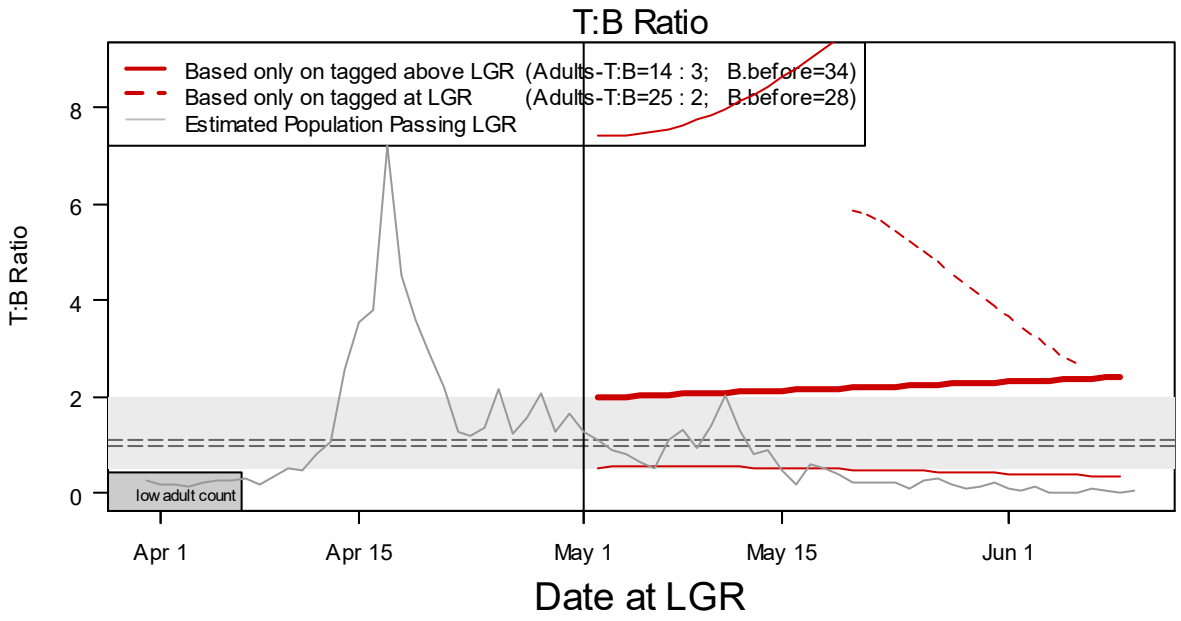
Transported or Bypassed at Lower Monumental Dam



Wild Chinook 2016

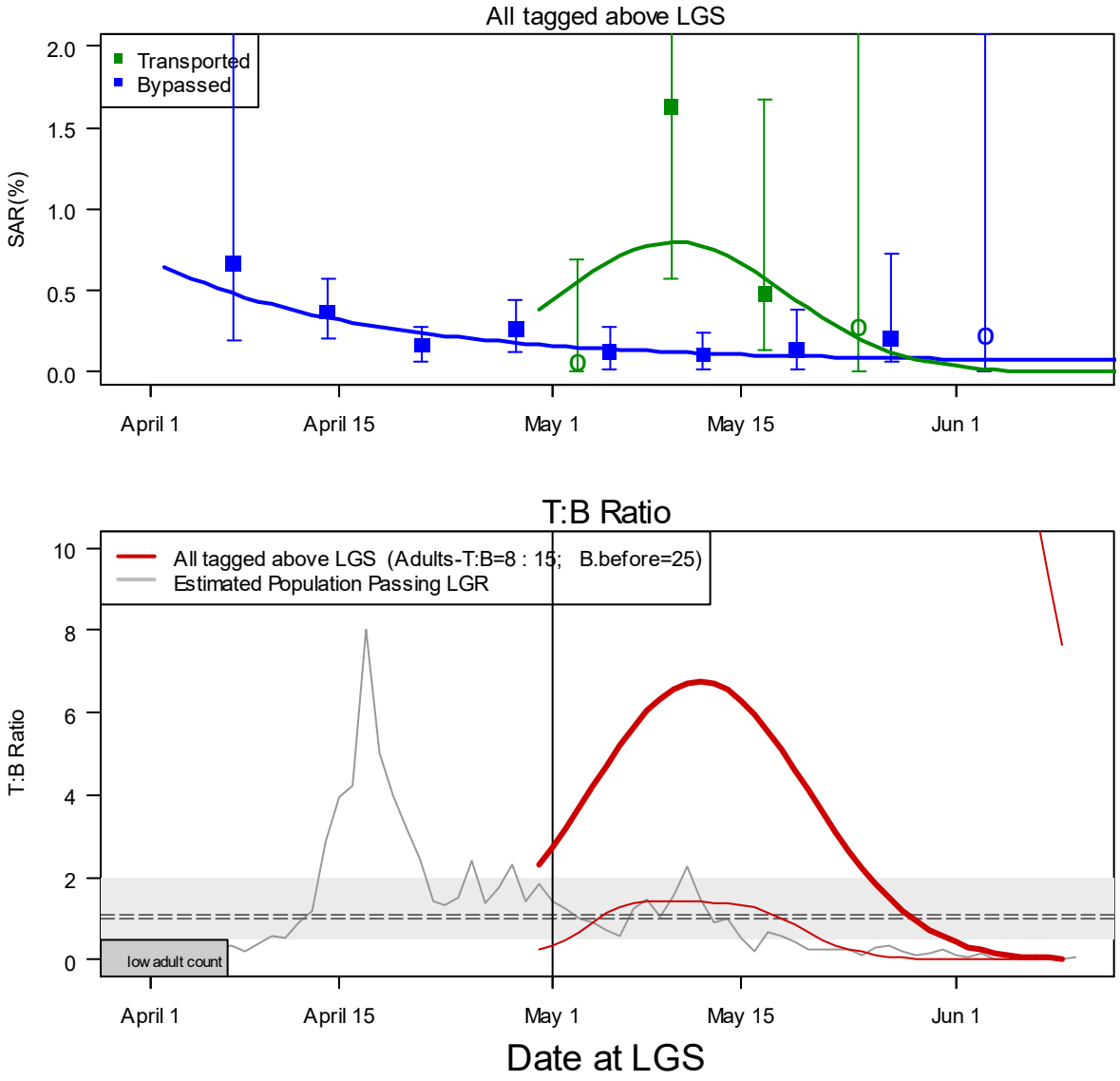
Transported or Bypassed at Lower Granite Dam





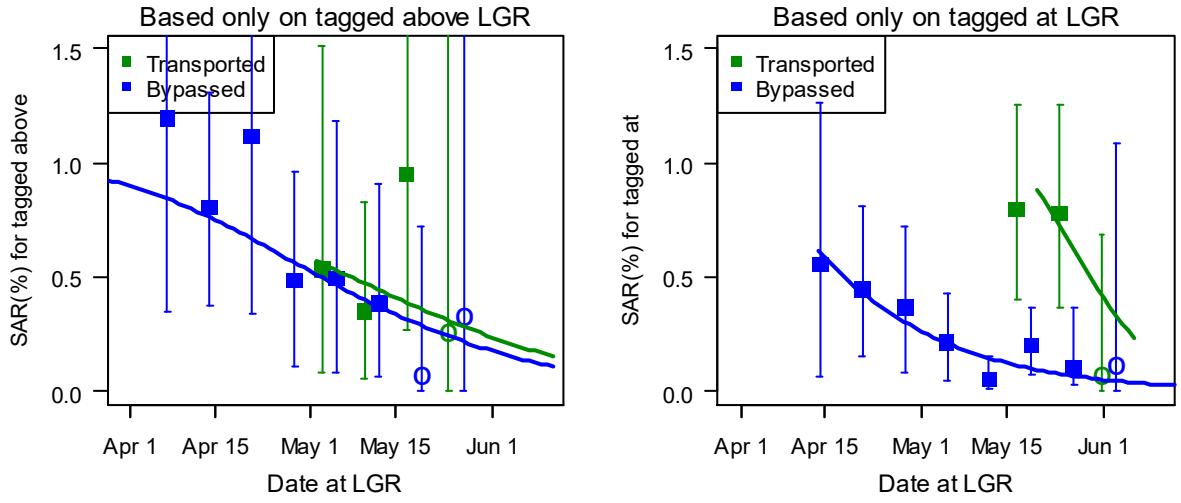
Wild Chinook 2016

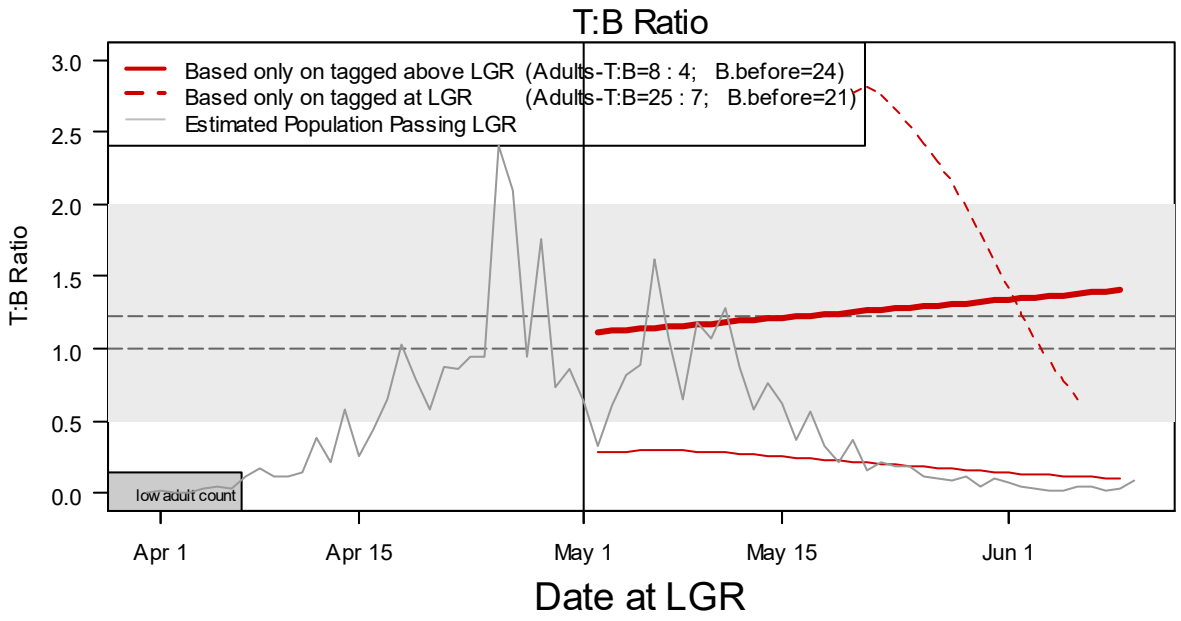
Transported or Bypassed at Little Goose Dam



Wild Steelhead 2016

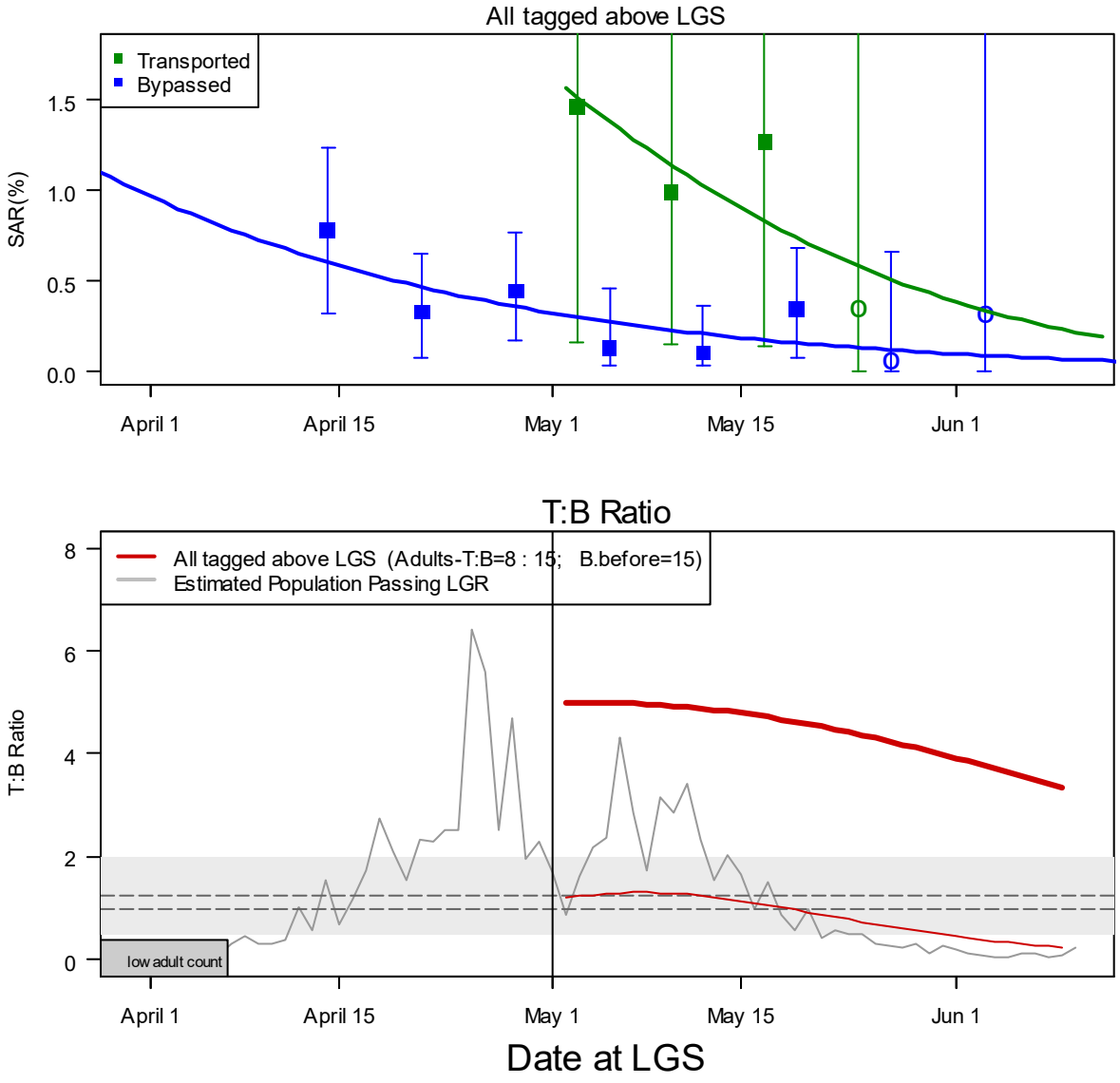
Transported or Bypassed at Lower Granite Dam





Wild Steelhead 2016

Transported or Bypassed at Little Goose Dam



Annual Summaries

Wild Chinook Salmon
Annual Summary

	Before Transport Began	During Transportation Period		
	SAR-Bypass	SAR-Transport	SAR-Bypass	T:B Ratio
LOWER GRANITE DAM				
2014	0.58 (0.44-0.72)	1.04 (0.72-1.43)	0.23 (0.09-0.38)	4.48 (2.36-11.3)
2015	0.30 (0.09-0.50)	1.35 (0.61-2.38)	0.04 (0.00-0.34)	34.0 (4.82-56.2)
2016	0.32 (0.22-0.43)	0.64 (0.37-1.00)	0.15 (0.02-0.34)	4.24 (1.48-36.1)
LITTLE GOOSE DAM				
2014	0.69 (0.56-0.82)	0.51 (0.26-0.85)	0.17 (0.09-0.28)	2.93 (1.33-6.29)
2015	0.21 (0.06-0.46)	1.23 (0.62-1.95)	0.06 (0.02-0.20)	21.8 (4.95-104)
2016	0.26 (0.18-0.36)	0.68 (0.26-1.17)	0.15 (0.08-0.23)	4.20 (1.61-9.71)
LOWER MONUMENTAL DAM				
2014	0.69 (0.48-0.89)	0.50 (0.18-0.91)	0.30 (0.18-0.46)	1.63 (0.47-3.80)
2015	0.29 (0.08-1.02)	0.10 (0.00-0.90)	0.05 (0.00-0.40)	NA
2016	0.31 (0.18-0.45)	1.04 (0.30-2.28)	0.11 (0.03-0.25)	8.82 (1.46-45.9)

Wild Steelhead
Annual Summary

	Before Transport Began	During Transportation Period		
	SAR-Bypass	SAR-Transport	SAR-Bypass	T:B Ratio
LOWER GRANITE DAM				
2014	1.64 (1.08-2.20)	2.36 (1.86-2.93)	0.89 (0.55-1.28)	2.64 (1.72-4.56)
2015	0.28 (0.08-0.97)	0.16 (0.05-0.56)	0.20 (0.06-0.72)	0.78 (0.08-7.10)
2016	0.73 (0.49-1.07)	0.50 (0.19-0.86)	0.27 (0.08-0.52)	1.87 (0.60-11.4)
LITTLE GOOSE DAM				
2014	1.14 (0.75-1.57)	2.12 (1.54-2.79)	0.60 (0.43-0.79)	3.61 (2.36-5.56)
2015	0.12 (0.00-1.03)	0.16 (0.05-0.55)	0.15 (0.04-0.52)	1.06 (0.12-9.71)
2016	0.48 (0.30-0.67)	1.20 (0.55-2.12)	0.26 (0.14-0.39)	4.40 (1.88-9.67)
LOWER MONUMENTAL DAM				
2014	1.49 (0.68-2.46)	1.45 (0.74-2.29)	0.55 (0.34-0.78)	2.79 (1.29-5.04)
2015	0.66 (0.00-5.77)	0.15 (0.00-1.34)	0.18 (0.00-1.58)	NA
2016	0.42 (0.15-0.74)	1.82 (0.64-3.29)	0.16 (0.02-0.35)	11.4 (3.20-75.5)

Summary / Conclusions

- 2014: T:B ratio > 3 for wild Chinook at LGR and LGS
  T:B ratio between 2 and 3 for Steelhead at all 3 dams

- 2015: SAR ~ 1.0% for transported wild Chinook
  near 0% for wild Chinook bypassed in May
  Poor data for wild Steelhead

- 2016: T:B ratio > 2 for wild Chinook at all 3 dams
  For steelhead, T:B ratio between 1 and 1.5 at LGR,
  ~3 at LGS, very high at LMN

Summary / Conclusions

- Results tend to be similar for Lower Granite and Little Goose Dams
  - About 75-80% of transported fish

- Lower Monumental: fewer fish transported, less PIT-tag data, lower T:B ratios (often ~ 1.0)

Summary / Conclusions

- Less seasonality in T:B ratios in recent years (lines flatter)
- Higher than average T:B ratios in May 2014 and 2016 and much higher in 2015 (very low SAR for bypassed fish)
- More fish migrating in April in recent years
  - After 10 years without significant transport data from April-migrating fish, transportation began on April 24, 2018

Next for this project

- Further data reduction through multi-year analysis with parameters tied across years
- Updated report completed in 2019

Questions?